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DEPARTMENT OF THE ARMY FIELD MANUAL

RADAR SET AN/MPQ-4A



HEADQUARTERS, DEPARTMENT OF THE ARMY
MAY 1961

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HEADQUARTERS,
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RADAR SET AN/MPQ-4A

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CHAPTER 1

GENERAL

1. Purpose

This manual is a guide for the commander in developing field artillery radar sections, employing the radar set AN/MPQ-4A, into efficient teams.

2. Scope

a. This manual covers the organization, tactical employment, individual duties of section personnel; techniques of operation of the radar set AN/MPQ-4A in accomplishing the missions of weapons location and radar gunnery; decontamination and destruction of equipment; safety precautions; and section training.

b. The material presented herein is applicable, without modification, to both nuclear and nonnuclear warfare.

c. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the United States Army Artillery and Missile School, Fort Sill, Okla.

3. Equipment

a. The major components of the radar set AN/MPQ-4A are the radar (fig. 1) and the power unit.

b. The radar consists of the antenna group, control-indicator group, dehydrator, electronic equipment trailer, receiver-transmitter group, and shelter. These groups are discussed in detail in TM 11-5840-208-10 to include nomenclature, technical characteristics, and operation of the equipment.

c. The power unit, PU-304A/MPQ-4A or PU-304B/MPQ-4A, consists of a $\frac{3}{4}$ -ton cargo trailer and generator set, gasoline engine PU-107A/U.

4. References

Related publications are listed in the appendix.

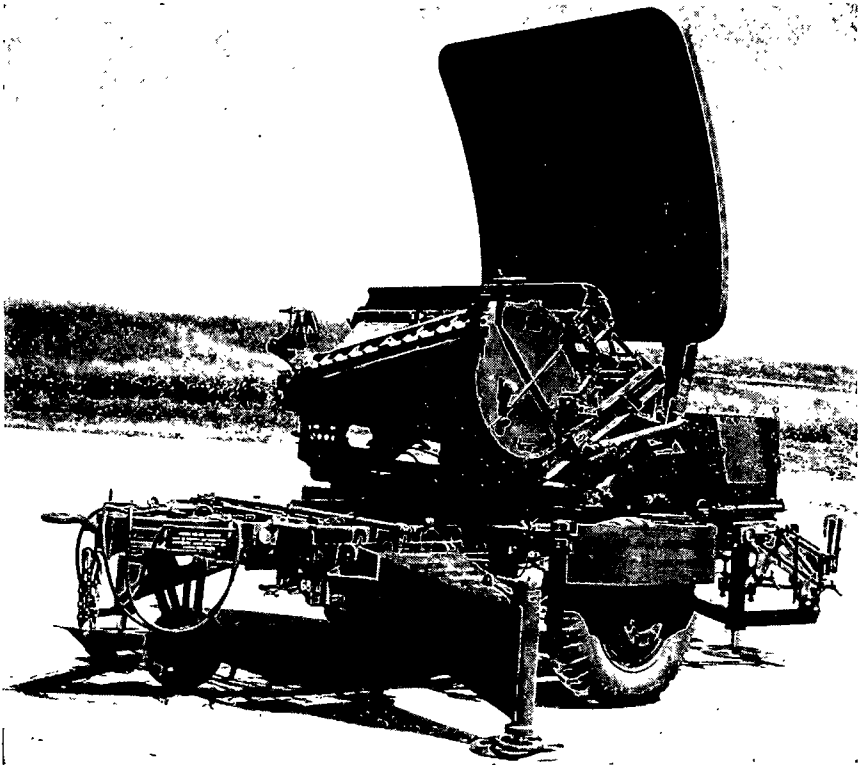


Figure 1. Radar set AN/MPQ-4A.

CHAPTER 2

ORGANIZATION

5. General

Radar sections equipped with the radar set AN/MPQ-4A are organic to TOE 6-101D, Headquarters and Headquarters Battery, Infantry Division Artillery, and TOE 6-316D, Headquarters and Headquarters Battery, Armored Division Field Artillery Howitzer Battalion. The primary mission of the radar section is the location of hostile mortars and artillery weapons. A secondary mission, which may be assigned to the radar section, is radar gunnery.

6. Composition of the Radar Sections

a. *Countermortar Radar Section, Headquarters and Headquarters Battery, Infantry Division Artillery (TOE 6-101D).* Three countermortar radar sections are organic to the infantry division artillery. Each section consists of eight enlisted men as follows:

- (1) Section chief.
- (2) Radar mechanic.
- (3) Senior radar operator.
- (4) Two radar operators.
- (5) Two assistant radar operators.
- (6) Generator operator.

b. *Countermortar Radar Section, Headquarters and Headquarters Battery, Armored Division Field Artillery Howitzer Battalion (TOE 6-316D).* The countermortar radar section consists of one officer and 10 enlisted men, as follows:

- (1) Radar officer.
- (2) Section chief.
- (3) Radar mechanic.
- (4) Senior radar operator.
- (5) Radar operator.
- (6) Two radar plotters.
- (7) Light truck driver.
- (8) Generator operator.
- (9) Two radiotelephone operators.

7. General Duties of Personnel

a. *Section Chief.* The section chief is the noncommissioned offi-

cer in command of the section. He is responsible to the officer in charge for—

- (1) Training and efficiency of the section personnel.
- (2) Selection and occupation of the radar position when so directed.
- (3) Supervision of emplacement, march order, operation, maintenance, and inspection of section equipment.
- (4) Compliance with safety precautions.
- (5) Preparation of field fortifications for protection of equipment and personnel.
- (6) Local security.
- (7) Camouflage discipline.
- (8) Chemical, biological, and radiological warfare training.
- (9) Maintenance of the section area.

b. Radar Mechanic. The radar mechanic is responsible to the chief of section for second-echelon maintenance of the radar. He supervises the operators in the replacement of certain parts and is personally responsible for making checks and adjustments beyond the capability of the operators.

c. Radar Operators. The radar operators are responsible for the operation of the radar set and preventive maintenance to include replacement of certain fuses and lamps.

d. Generator Operator. The generator operator is responsible for the operation and first echelon maintenance on the power unit PU-304A/MPQ-4A or PU-304B/MPQ-4A.

CHAPTER 3

TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

8. General

The tactical employment and position requirements for the radar set AN/MPQ-4A depend on the tactical mission assigned the radar section. Other factors (technical and tactical) that influence the operations of this equipment must be considered. The suitability of a radar position can only be determined by the accomplishment of the assigned mission from that position.

9. Selection of Site

a. To insure complete coverage of the target area, coordination of the sectors of search for all radars is essential. The responsibility for this coordination rests with the division artillery commander. There is a countermortar intelligence officer (assistant S2) to assist him. The countermortar intelligence officer (CMIO) takes the necessary measures to assure the division artillery commander that the entire division front is covered as completely as possible. Within the infantry division artillery, radar tactical missions are normally assigned by the division artillery S3. The radar sections will normally be employed with a direct support field artillery battalion. In the armored division artillery, however, the countermortar radar section is organic to the direct support battalion. All tactical missions assigned to the section are determined by the battalion commander of the parent unit. The battalion commander will normally assign missions based on the recommendations of his radar officer.

b. The primary considerations governing the selection of the radar position area are—

- (1) The integration of the radar zone of search with the zones of other units as directed by the commander.
- (2) The technical capabilities and limitations of the radar set.

c. In the infantry division artillery, the general position area, in which the radar section may select positions, is designated by the countermortar intelligence officer (CMIO); however, the battalion commander of the armored division artillery battalions normally designates this area. Such designations are made on the advice of the countermortar intelligence officer (CMIO) and should

encompass an area sufficiently large to enable the radar officer (chief of section) to select the actual radar site, based on technical considerations affecting the operation of the radar. The radar position area should be within the battalion area and, if possible, adjacent to one of the firing batteries. Such a position simplifies communications, facilitates survey and logistics, and enables the section to take advantage of any defensive perimeter. Depending on the mission, terrain and situation, the radar position area will be located from 2,000 to 4,000 meters behind the forward edge of the battle area. This gives the radar section flexibility of action in both the offense and the defense. During offensive action, the position should be well forward to avoid early displacement. In the defense, the position will be located further rearward in a position area designated by the division artillery commander in order to provide depth to the radar operations of the defensive force as a whole.

d. In addition to the foregoing, the battalion commander of the armored field artillery battalion also designates the sector of search for the radar if not previously designated by higher authority. This sector of search will normally coincide with the zone of action of the supported unit.

e. After designation of the general position area, the radar officer (chief of section) makes a reconnaissance prior to making the actual selection of the radar position. If time permits, this reconnaissance will be divided into two phases—a map reconnaissance and a ground reconnaissance.

(1) The map reconnaissance is made to determine, but is not limited to the following:

- (a) Possible site locations.
- (b) Routes into and out of the area.
- (c) Identifying landmarks.
- (d) Adjacent units.

(2) A ground reconnaissance follows the map reconnaissance to insure a rapid occupation of the selected position. The ground reconnaissance is based on the tactical and technical considerations for the radar. This enables the radar officer (chief of section) to make decisions and issue orders concerning the following:

- (a) Exact location of the radar.
- (b) Location of the radar operations center.
- (c) Location of the generator.
- (d) Location of the truck park.
- (e) Routes into and out of the area.
- (f) Searching and marking the area for mines.

- (g) Local security (to include camouflage and defense against air and ground attack).
- (h) Selection of alternate positions.

Note. The above list is not all-inclusive and should be modified as dictated by the particular mission, situation, and terrain. The time for reconnaissance generally is limited; the reconnaissance must be organized so that it can be accomplished as completely as possible in the time allotted.

10. Tactical Considerations

The tactical considerations in selecting a radar site are similar with those considered in choosing a position for a field artillery firing battery or similar unit. Normally, these considerations should include—

a. Communications. The communication requirement will vary, depending on the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are normal means of communication for the radar section. For communication diagrams see FM 6-10, Field Artillery Communication.

b. Concealment. In selecting a site for the radar, advantage must be taken of natural concealment, such as trees and shrubs.

c. Cover. The radar must be emplaced in defilade to the enemy to afford personnel and equipment all possible protection from hostile fire.

d. Routes of Approach. A site should be selected that has more than one route of approach that will allow occupation without being observed by the enemy. Road conditions, overhead clearances, bridges, and stream fords must be considered.

e. Security. If possible, a site should be selected within an established defense perimeter. This will ease the local security requirements for the radar section.

f. Survey. The closer the site is to a firing battery or a known survey point, the more rapidly survey or organic radar personnel can determine coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes.

11. Technical Considerations

a. Radar is a line-of-sight instrument; that is, the transmitted and echo waves travel in straight lines. Since this is the case, it might appear that the best site for a field artillery radar would be on top of a hill or at least on high terrain so that the radar has a clear line of sight in all directions. When the radar is placed in such a site, however, the waves of energy transmitted by the radar reflects from objects such as hills, buildings, and heavy foliage.

These reflected waves cause a large portion of the B-scope to be covered with "clutter" or unwanted echoes. This clutter makes the detection of projectile echoes in the area virtually impossible. To reduce clutter to a minimum in the sector of search, it is necessary to emplace the radar behind a hill or ridge, called a screening crest. The distance from the radar to the screening crest should be between 250 and 1,000 meters. Even though clutter is still being received from the screening crest, the screening crest is close enough to the radar that the B-scope is clear at ranges where enemy projectiles are expected. The angle of elevation to the screening crest should be from 15 to 40 mils.

b. Other technical considerations that should be considered in selecting the radar site are—

- (1) Maximum range of the radar.
- (2) Sector of search.

CHAPTER 4

EMPLACEMENT AND MARCH ORDER

Section I. GENERAL

12. Transportation of Equipment and Personnel

The equipment and personnel of the radar section are transported in two sections.

a. The radar set AN/MPQ-4A and its prime mover make up one section.

b. The power unit PU-304A/MPQ-4A or PU-304B/MPQ-4A and its prime mover make up the second section.

13. Organization of the Radar Site

a. The radar site consists of the following installations:

- (1) Radar operations center.
- (2) Radar with control unit mounted on radar trailer.
- (3) Power unit.
- (4) Motor park.

b. The radar officer (chief of section) is responsible for the reconnaissance, selection, occupation, and organization of the position. Dispersion of (1), (2), and (3) in *a* above is limited to 150 feet for remote operation and 101 feet for local operation. Sites selected for the radar and the power unit should be level. If not level, slope must not exceed 90 mils.

Section II. EMPLACEMENT

14. General

a. The number of personnel in the radar section will vary according to the unit table of organization and equipment. The emplacement procedures listed in paragraph 15 are based on a team consisting of the following personnel:

- (1) Section chief.
- (2) Radar mechanic.
- (3) Senior radar operator (SRO).
- (4) Radar operators (Nos. 1, 2, 3, and 4).
- (5) Generator operator (No. 5).

b. Caution must be exercised by all personnel in emplacing the equipment to prevent damage to equipment and injury to personnel.

15. Individual Duties

The following description of individual duties is based on a type section (par. 14). Since radar sections vary in size from the armored division to the infantry division, the duties must be assigned as required. Individual duties of personnel in emplacing the radar are as follows:

- | | |
|--------------------------------------|--|
| Step 1. Section chief | Locates radar in a suitable position and generator within required distance of radar. Commands PREPARE FOR ACTION. Directs and supervises all phases of emplacement. |
| Step 2. SRO, No. 3, and No. 4 | Lower rear outrigger bracket:
a. Release both lower transit screws on main outrigger frame; lower frame into position and secure with front operational locking screws (fig. 2).
b. Release both pivot screws and upper transit locking screws on rear assembly and rotate to vertical position. Secure with rear operational locking screws (fig. 3), and tighten pivot screws.
c. Remove control-indicator cover. |
| Step 3. No. 1 and No. 2 | Set brakes on radar and unhook radar from prime mover. Release retaining posts on two side outriggers (fig. 4); lower and fasten into place with locking screws (fig. 5). |
| Step 4. SRO, No. 3, No. 4, and No. 5 | Emplace generator; roll up canvas; place gas cans and fire extinguisher on ground; remove electrical equipment shelter from bracket. |
| No. 5 | Start generator. Do not apply power. |

- | | |
|---|---|
| Step 5. No. 1 and No. 2 | Place jack pads beneath leveling posts. Lower side jacks into position (fig. 5). |
| No. 3 and No. 4 | Remove power cable from the reel and connect to the external receptacle on the generator and to the jack on the control-indicator. |
| Radar mechanic | Supervises removal and connecting of control cables. |
| | <i>Note.</i> Connect control cable if necessary. |
| Caution: The guide keys on both the pedestal control cable and the remote control cable are easily sheared off. EXTREME care must be taken in hooking up these cables to prevent shearing the keys and also to prevent installing the cable upside down in case the key is sheared. | |
| Step 6. SRO, No. 1, No. 2, and No. 3 | Open shelter cover. |
| No. 2 and No. 3 | Remove canvas and equipment picture frame. |
| SRO, No. 1, No. 2, and No. 3 | Place equipment picture frame on control-indicator group (fig. 6). |
| No. 1 and No. 2 | Fasten rear jack brace through hole provided in canvas into base of control-indicator group. |
| Step 7. No. 1 | Lowers rear jack onto jack pad. |
| Step 8. No. 5 | Disengages azimuth stow lock. If lock sticks, see paragraph 42, TM 11-5840-208-10. |
| Step 9. SRO | Directs No. 1, No. 2, and No. 3 in leveling the set. |
| No. 1, No. 2, and No. 3 | Level set by raising front leveling jacks first, while observing bubble. Raise rear jack as required. |
| Step 10. No. 4 and No. 5 | Release locking pads from reflector (fig. 7); turn reflector elevation crank to raise reflector into position (fig. 8). Release clamping screws and secure reflector (fig. 8). Release locking pins and drop fenders. |

No. 4	Pulls out azimuth handwheel locking pin in front of pedestal to release the handwheel shaft.
No. 4 and No. 5	Open all vents. <i>Note 1.</i> Two vents are under the pedestal. <i>Note 2.</i> The circular polarizer must be placed in the operational position (fig. 9) before opening the vents to the rear of the receiver-transmitter group. If polarizer is not to be used, place it back to its stowed position (fig. 8).
SRO and No. 1	Remove operator seats from traveling bracket and place on rear assembly.
No. 2 and No. 3	Secure legs of cover with diagonal support struts (fig. 10).
No. 2 and No. 3	Extend legs and secure with locking pins (fig. 10).
SRO, No. 1, No. 2, and No. 3	Invert cover and place on picture frame mounted on control-indicator group (fig. 11).
Step 11. No. 2 and No. 3	Place canvas cover over shelter.
SRO and No. 1	Remove fans from carrying bracket in generator. Install them in brackets provided in shelter (fig. 11). Connect cables.
Step 12. SRO	Applies power to radar and performs preoperation checks.

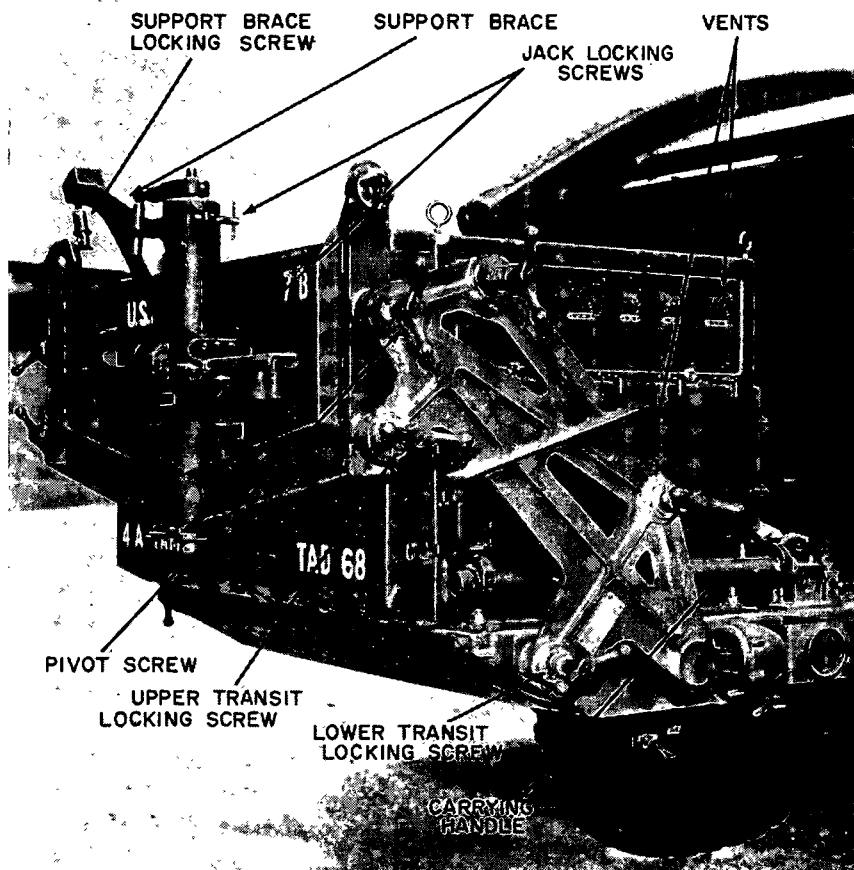


Figure 2. Rear outrigger arm in transit position.

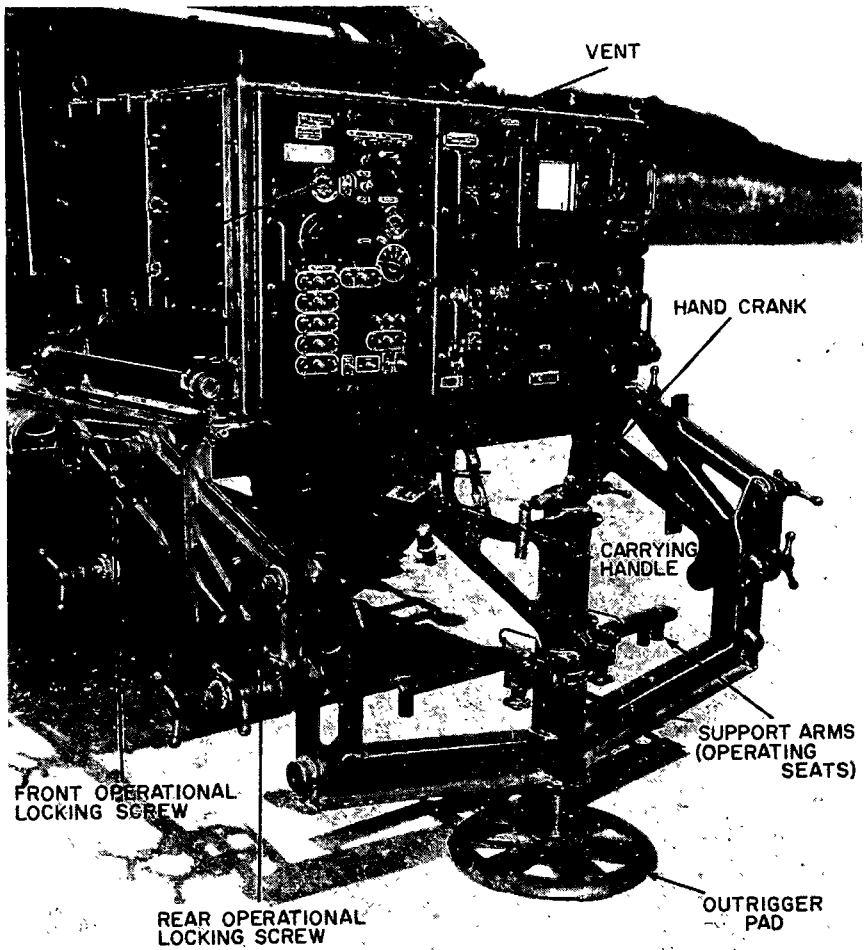


Figure 3. Rear outrigger arm in operational position.

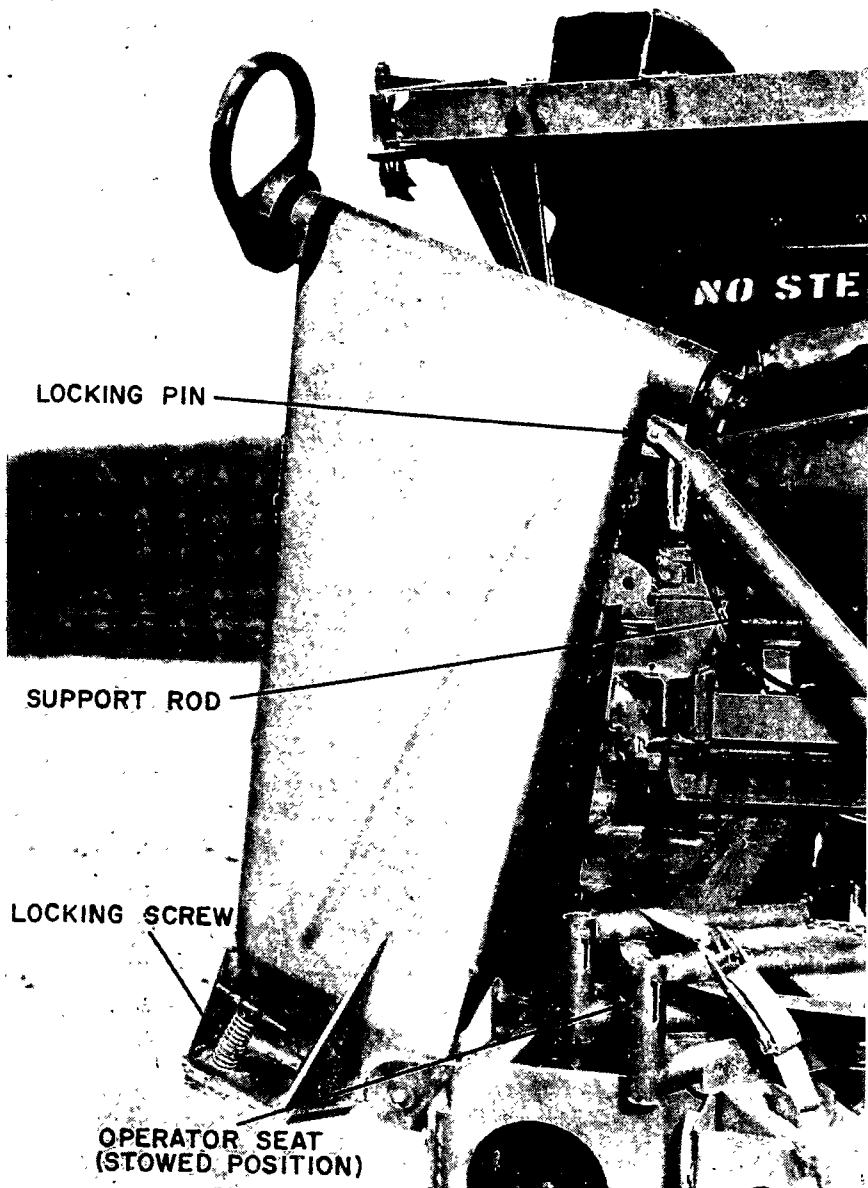


Figure 4. Side outrigger in transit position.

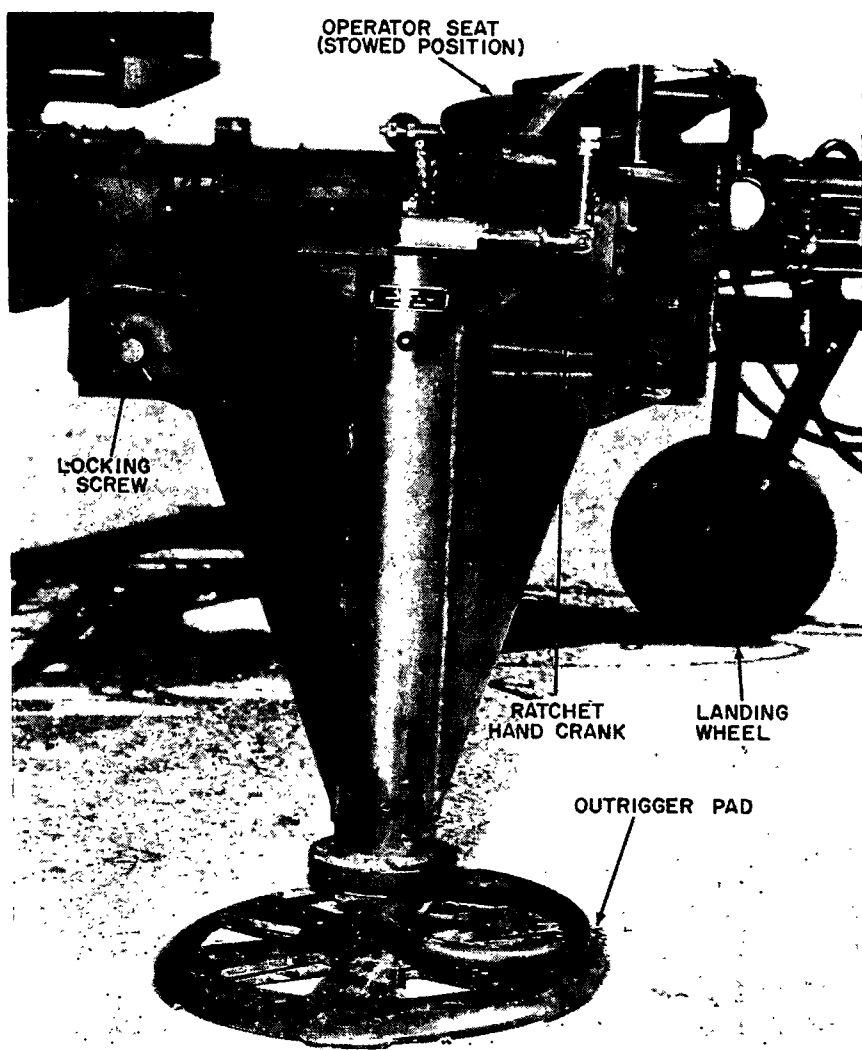


Figure 5. Side outrigger in operational position.

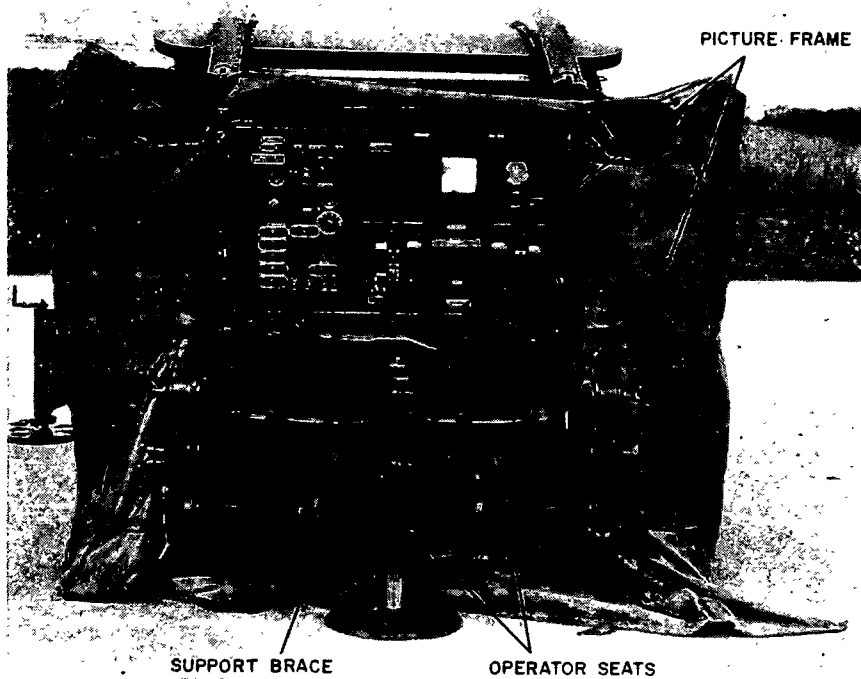


Figure 6. Picture frame on control-indicator group.

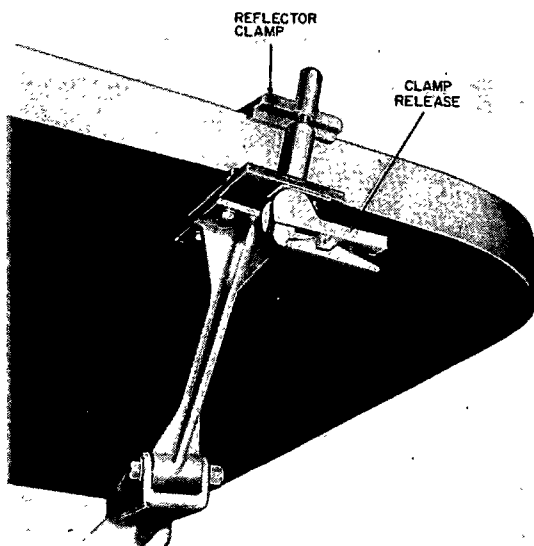


Figure 7. Reflector locking pads.

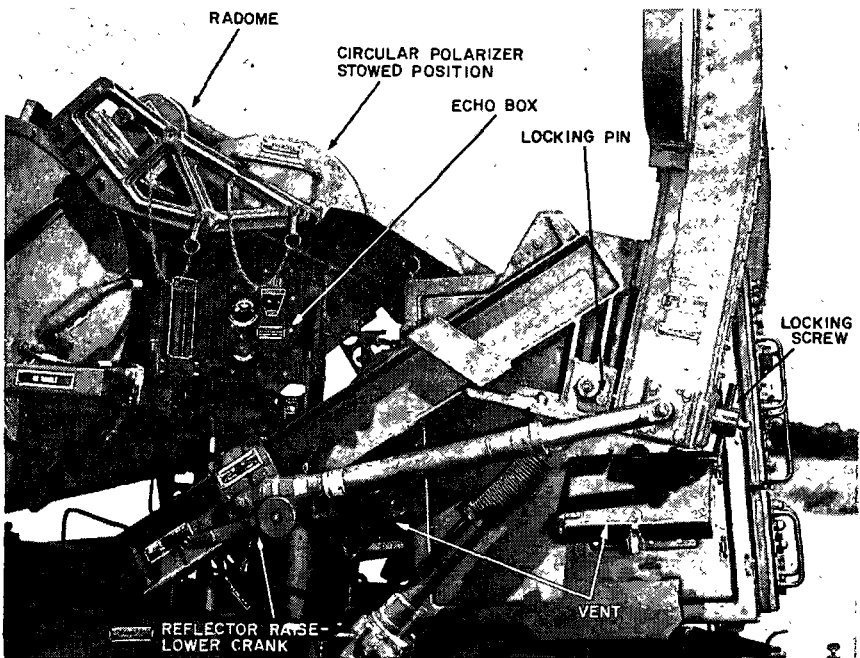


Figure 8. Part side view of radar set AN/MPQ-4A.

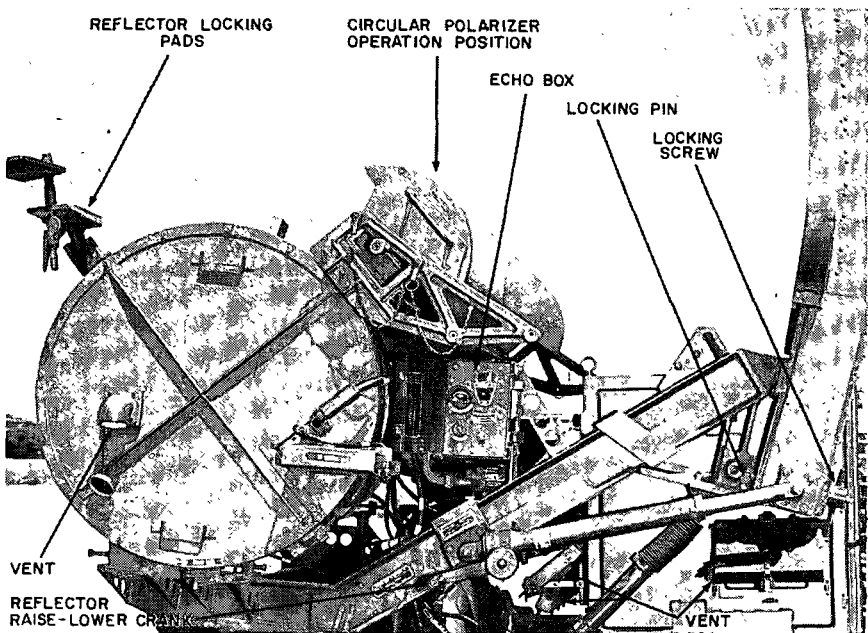


Figure 9. Circular polarizer in operational position.

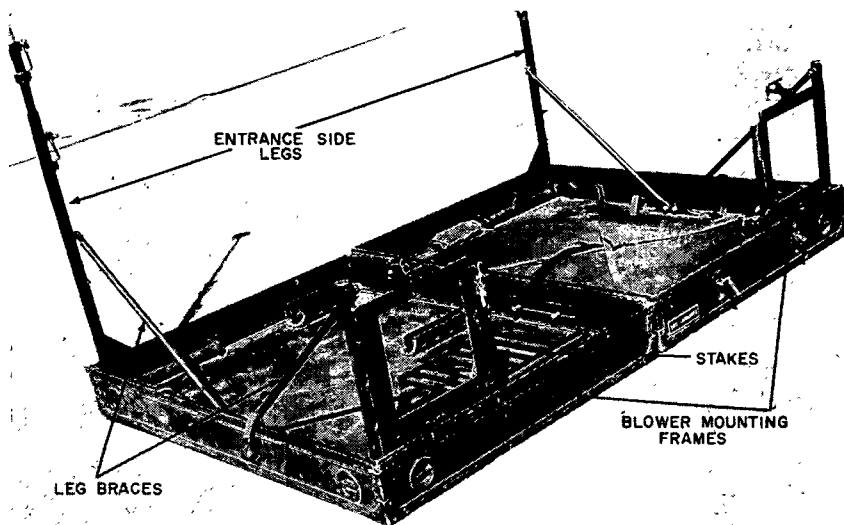


Figure 10. Shelter cover assembly.

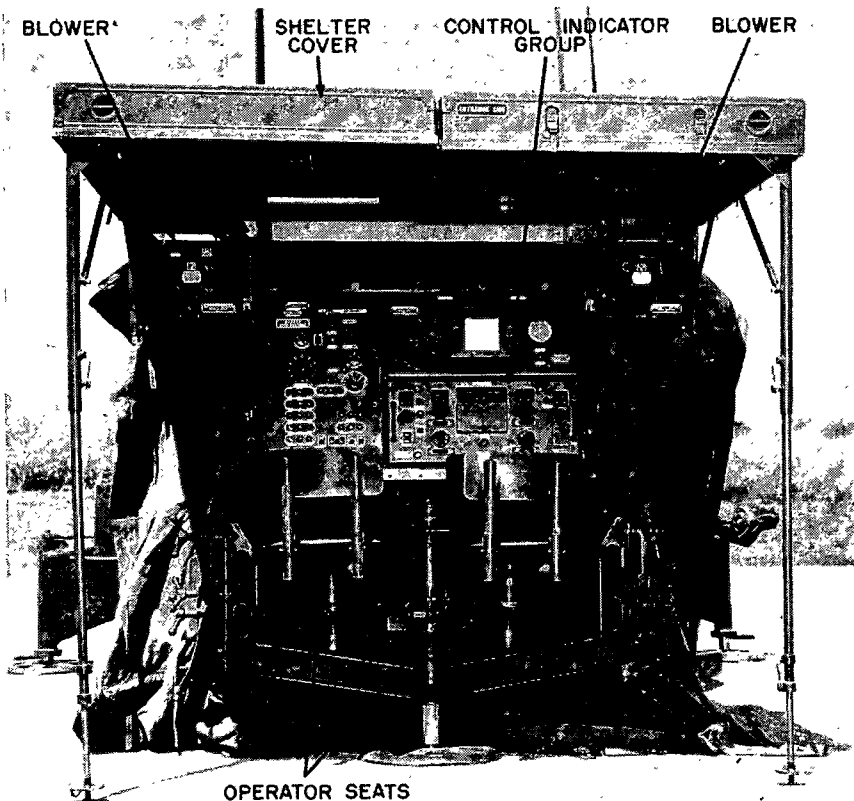


Figure 11. Control-indicator with shelter cover mounted.

Section III. MARCH ORDER

16. General

Precautions must be taken to prevent injury to personnel and damage to equipment during march order.

17. Individual Duties

The following description of duties is based on a type section (par. 14). The chief of section directs the operations, giving such orders, instructions, and signals as may be required to expedite and coordinate the work of the section. Individual duties of personnel in march order of the radar are as follows:

Step 1. Chief of section Commands MARCH ORDER.

Step 2. SRO Positions radar to the approximate azimuth for march order. Presses the elevation switch to raise or lower until the computer lower beam elevation counter reads 175 mils. Cuts off power at control unit.

Step 3. SRO and No. 1 Remove fans from shelter after disconnecting from control-indicator cabinet.

No. 2 and No. 3 Remove canvas cover from shelter.

No. 4 Engages azimuth handwheel.

No. 5 Engages azimuth stow lock.

No. 4 and No. 5 Close all vents.

Note 1. Two vents are under the pedestal.

Note 2. To close the vents on receiver-transmitter, the circular polarizer must be put in the operating position. Before lowering the reflector, the circular polarizer *must* be put back in the stowed position.

No. 4 and No. 5 Unlock reflector securing screws and lower reflector into traveling position; secure with locking pads.

No. 4 and No. 5 Place fenders in the traveling position and secure with locking pins.

Step 4. SRO, No. 1, No. 2, and No. 3 Remove shelter cover.

No. 2 and No. 3	Release diagonal support struts and secure legs of cover.
SRO and No. 1	Remove operator seats from rear assembly and mount in traveling bracket.
No. 2 and No. 3	Release rear jack brace from base of control-indicator group and remove equipment picture frame.
No. 2 and No. 3	Place equipment picture frame and canvas cover in the electrical equipment shelter and secure for travel.
SRO and No. 1	Replace cover on control-indicator group.
Step 5. No. 5	Shuts down generator after throwing the main power switch.
No. 3 and No. 4	Disconnect power cable from radar and generator and replace on reel on generator.
SRO, No. 1, and No. 2	Lower jacks and replace jack pads on traveling brackets.
No. 1 and No. 2	Release locking screws on side outriggers; raise and secure side outriggers to retaining posts.
SRO, No. 3, No. 4, and No. 5	Replace electrical equipment shelter and fans on brackets provided in generator.
No. 4 and No. 5	Secure generator for travel. Hook generator to prime mover and release handbrakes.
No. 1 and No. 2	Hook radar to prime mover and release handbrakes.
Step 6. SRO, No. 3, and No. 4	Raise rear outrigger bracket: - Release pivot screws and rear operational locking screws and turn assembly to horizontal position. Secure with upper transit locking screws and tighten pivot screws. - Release front operational locking screws and raise frame into traveling position. Secure with lower transit locking screws.

CHAPTER 5

PREOPERATION AND PERFORMANCE CHECKS

18. General

The procedures outlined in this section are necessary for efficient operation of the radar set AN/MPQ-4A. They should be accomplished in sequence when possible.

19. Preliminary Adjustments

Before power is applied to radar set AN/MPQ-4A, perform the following preliminary adjustments:

a. Receiver-Transmitter Group. Set the AFC-MANUAL switch on the control-monitor (fig. 12) panel to the AFC position. All other operating controls for this component are located on the control-power supply panel in control-indicator group.

b. Control-Power Supply (figs. 13 and 14). Set the control-power supply controls as follows:

Control	Position
MAIN POWER switch	OFF
AFC-MANUAL switch	MANUAL
TEST METER SELECTOR switch	27 V

c. Azimuth and Range Indicator (fig. 15). Set the azimuth and range indicator controls as follows:

Control	Position
PLOTTER DIMMER potentiometer	Fully counterclockwise.
PANEL DIMMER potentiometer	Fully counterclockwise.
EXPANDED SWEEP DELAY switch	5.
RANGE SELECTOR switch	10000 M.
BEAM VIDEO switch	BOTH
MARKERS switch	OFF (down)
RANGE SHIFT switch	OFF (down)
RANGE MARK potentiometer	Midposition.
AZIMUTH Mark potentiometer	Midposition.

d. Antenna Group. Check the antenna group to insure that—

- (1) Azimuth stow lock is out.
- (2) Azimuth handwheel is all the way out.
- (3) Fenders are down.

e. Interlock Circuits and Vents. Close the following interlocks and open the following vents:

- (1) On the control-indicator group, secure the control-power supply, indicator, and computer drawers. Open the air

intake and air exhaust panels on the left and right sides of the cabinet. Remove the cap from the vent at the upper right rear of the cabinet.

- (2) On the receiver-transmitter group, secure the control-monitor panel, the power supply drawer, and the transmitter door. Open the air intake and air exhaust panels on the rear of the cabinet and the air exhaust panel on the left side. Remove cap from vent at upper left rear of the cabinet.
- (3) On the dehydrator, open the air intake panel on the left side of the front panel.
- (4) Open vents on both ends of the scanner and under the pedestal.

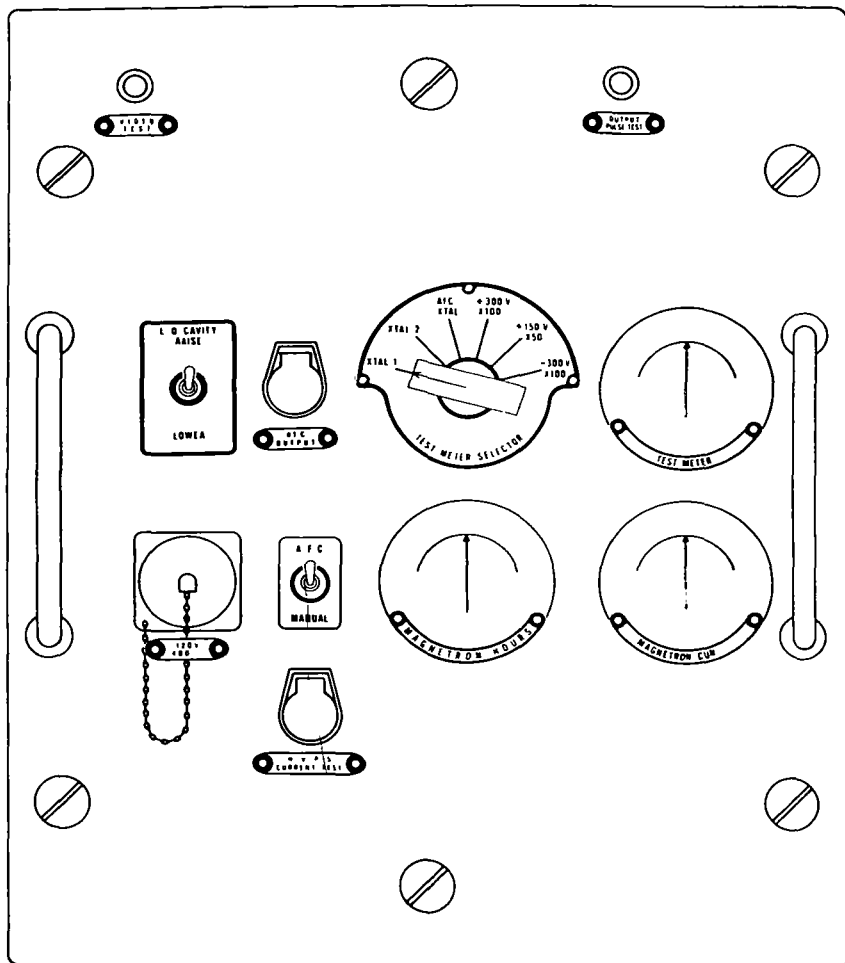


Figure 12. Control-monitor.

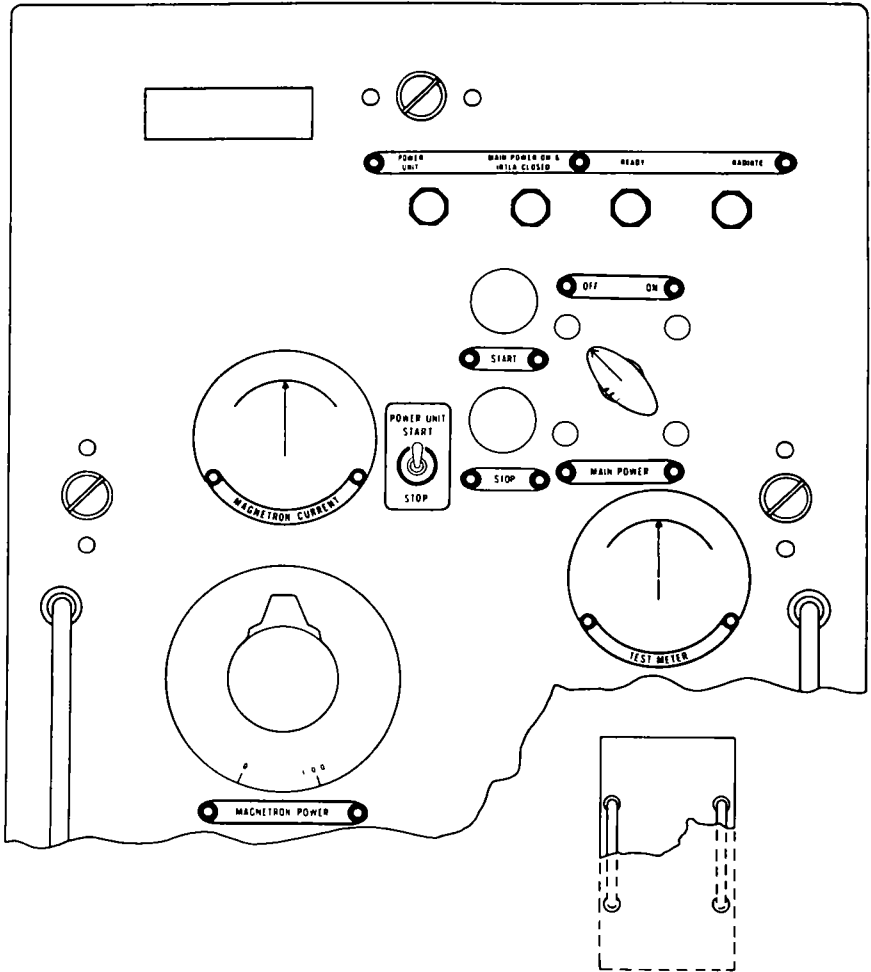
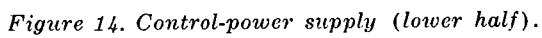


Figure 13. Control-power supply (upper half).



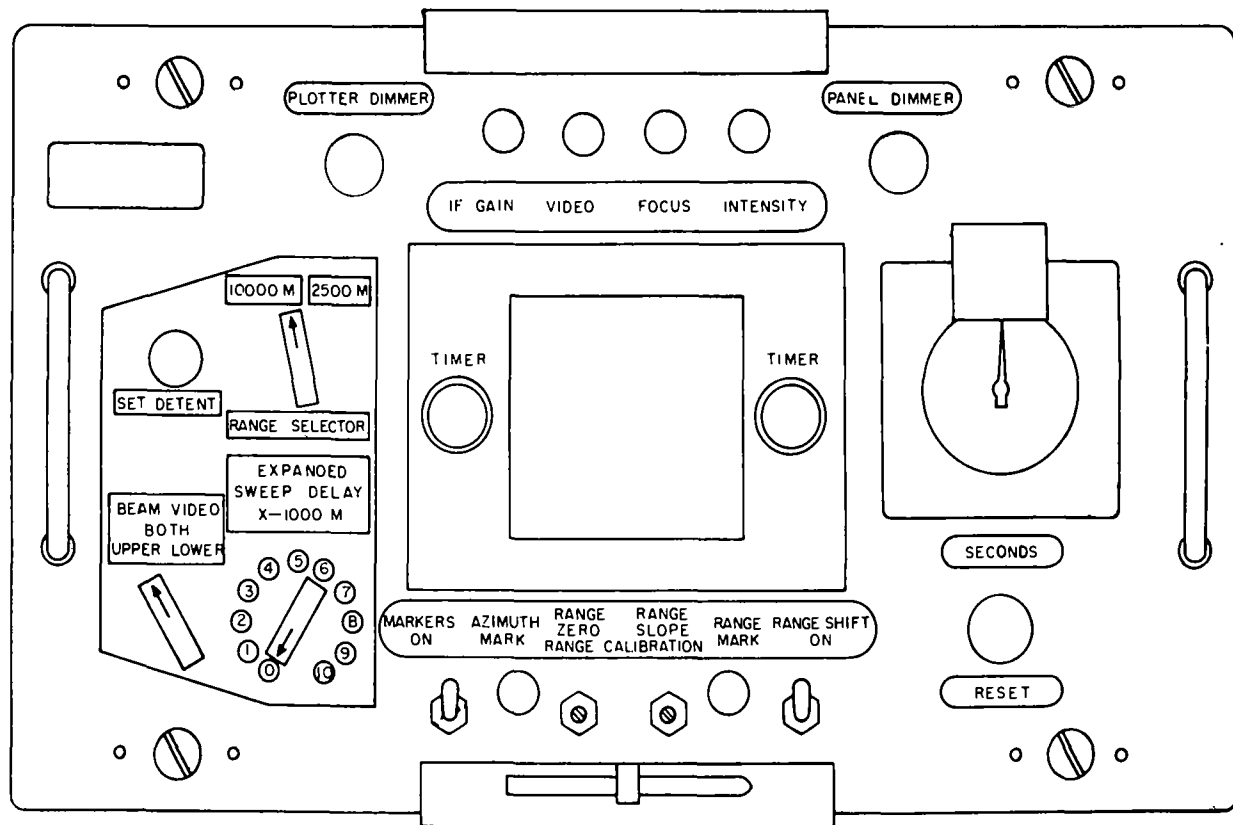


Figure 15. Azimuth and range indicator.

20. Starting Procedure

a. Check and start the generator PU-107A/U (TM 11-5840-208-10).

b. Check the power unit output for proper voltage and frequency. When these requirements are met, turn the power unit 400-cycle circuit breaker to ON. The POWER UNIT indicator lamp on the control-indicator group will light if the output phases of the generator are connected in proper sequence.

c. Turn the MAIN POWER switch to ON. The MAIN POWER ON & INTLK CLOSED indicator lamp will light, and the test meter on the control-power supply will indicate 27 volts.

d. Check for operation of the system blowers.

- (1) The main blower in the receiver-transmitter cabinet is operating if air is being discharged at the exhaust vent on the left side of the cabinet.

Warning: Do not reach into the transmitter compartment during the following check. Voltage in excess of 30,000 volts is present. The radar mechanic will normally perform this check.

- (2) Check the magnetron blower in the receiver-transmitter cabinet. Open the transmitter compartment door. With the power on, a current of air will be felt from the compartment, indicating blower operation. Close and secure the door.

- (3) The control-indicator blower is operating if air is being discharged at the exhaust vent on the right side of the cabinet.

e. While waiting for the 5-minute delay relay to close, perform the following checks and adjustments:

- (1) After 30 seconds, rotate the TEST METER SELECTOR switch on the control-power supply and on the control-monitor through the positions listed in (a) and (b) below. The meter should read as follows:

(a) At the control-power supply:

Switch position	Meter scale	Typical reading	Actual value
440 V X100	0-5	4.4	440 volts
220 V X50	0-5	4.4	220 volts
27 V X10	0-5	2.7	27 volts
-220 V X50	0-5	4.4	-220 volts

(b) At the control-monitor:

<i>Switch position</i>	<i>Meter scale</i>	<i>Typical reading</i>	<i>Actual value</i>
XTAL 1	0-5	2.5	0.5 milliamperes
XTAL 2	0-5	2.5	0.5 milliamperes
+300 V X100	0-5	3.0	300 volts
+150 V X50	0-5	3.0	150 volts
-300 V X100	0-5	3.0	-300 volts

(2) Operate the AZIMUTH switch to the CW position and then to the CCW position. The antenna should rotate correspondingly.

(3) Operate the ELEVATION switch. In the RAISE position, the reflector should tilt upward. In the LOWER position, the reflector should tilt downward.

f. After the 5-minute delay, the READY indicator lamp on the control-power supply panel will light. Check to see that the dehydrator pressure gage reads approximately 12 psi (pounds per square inch) and that the dry air indicator is blue.

g. Adjust MAGNETRON POWER variac to a position between 0 and 25. Press the START button. The RADIATE indicator lamp will light. Adjust the variac until the MAGNETRON CURRENT meter reads 22 ma (milliamperes).

h. At the azimuth and range indicator:

(1) Set the VIDEO control at maximum and the IF GAIN at minimum.

(2) With the RANGE SELECTOR switch in the 10000 M position, adjust the INTENSITY control until raster is just visible.

(3) Switch RANGE SELECTOR switch to 2500 M position. If intensity of raster changes noticeably, have the mechanic adjust intensity balance.

(4) Adjust the FOCUS control for sharpest lines and images.

(5) Adjust the IF GAIN control until the background noise is just noticeable.

(6) Adjust the RANGE MARK control until the range strobe is visible.

(7) Adjust the AZIMUTH MARK control until the azimuth strobe is visible.

(8) Place the AFC-MANUAL switch in the AFC position.

(9) Turn the MARKERS switch to ON. Range markers should appear at ranges of 2,000, 4,000, 6,000, 8,000, and 10,000 meters. If the markers do not appear, the most probable cause is improper tuning of the local oscillator.

i. Tune the local oscillator.

- (1) Place AFC-MANUAL switch in the MANUAL position.
- (2) If markers did not appear in (9) above, operate the LO switch in the RAISE position until the markers appear. If no markers appear within 40 seconds, operate the LO switch in the LOWER position. If markers have not appeared within 2 minutes, call the radar mechanic.
- (3) When the range markers appear, operate the LO switch in the RAISE position and, then the LOWER position, until maximum marker intensity is obtained. Return the AFC-MANUAL switch to the AFC position. Marker intensity should remain unchanged.
- (4) If a decrease in marker intensity occurs, have the radar mechanic adjust the AFC circuit.

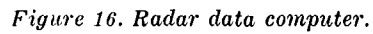
Note. There are two local oscillator frequencies that will cause the range markers to appear at full brilliance; one is 30 megacycles above the transmitter frequency, and the other is 30 megacycles below. The lower frequency is correct and is the only frequency where the AFC circuit will "lock in." Proper action of the AFC circuit is indicated by the range marker intensity being unchanged and AFC crystal current steady when the AFC-MANUAL switch is in the AFC position. AFC crystal current may be measured on the test meter by setting the TEST METER SELECTOR switch in the AFC XTAL CUR position. The normal meter reading is 2.5 (0.5 ma).

- (5) If the range markers faded out entirely when the AFC-MANUAL switch was placed in AFC position, the local oscillator is probably tuned to the wrong frequency. To correct this, place the AFC-MANUAL switch to MANUAL and operate the LO switch in LOWER until range markers reappear. Adjust local oscillator for maximum intensity of range markers. Return the AFC-MANUAL switch to AFC. No change in marker intensity should occur.

j. Turn the MARKERS switch to OFF.

21. Range Calibration

a. *General.* In order to obtain accurate range data and an end result of accurate weapons locations, the radar set AN/MPQ-4A must be range calibrated. Range calibration consists of alining the range circuits so that the radar will read the correct range. In the case of the AN/MPQ-4A, the operator performs range calibration. Range markers are used to calibrate, and a fixed point may be used to check calibration. Range calibration should be performed each time the set is emplaced and checked at least once a day during operation.



b. Procedure for Range Calibration Using Range Markers.

- (1) Apply power to the radar, turn the transmitter on, and tune the local oscillator.
 - (2) Turn the RANGE SHIFT switch (fig. 15) to the OFF position to prevent the operator from confusing the two range strobes.
 - (3) Set the detent switch (fig. 16) to the OFF position and set Δ RANGE in detent. This will allow any given range to be set into the computer.
 - (4) Set the range to 2,000 meters by using the LOWER BEAM RANGE control.
 - (5) Set the RANGE SELECTOR switch to the 2,500 M position to expand the sweep.
 - (6) Set the EXPANDED SWEEP DELAY switch to position 1.
 - (7) Turn the MARKERS switch (fig. 15) to the ON position.
- Note.* An adjustment of IF GAIN and/or LOCAL OSCILLATOR (figs 14 and 15) may be necessary to cause the markers to appear at proper intensity.
- (8) If the range marker does not fall exactly over the strobe, adjust the RANGE ZERO control (fig. 15) until it does.
 - (9) Turn the EXPANDED SWEEP switch to position 7.
 - (10) Move the range strobe to 8,000 meters.
 - (11) If the range mark does not appear exactly over the strobe, adjust the RANGE SLOPE control (fig. 15) until it does.
 - (12) Since RANGE ZERO and RANGE SLOPE controls interact, recheck SLOPE at 8,000 meters after each change in ZERO at 2,000 meters and recheck ZERO at 2,000 meters after each change in SLOPE at 8,000 meters.

Note. If desired, range calibration may be checked by measuring the range to an electrical target with the radar set. This reading should agree with survey data within 20 meters.

22. Radar Performance Checks

Overall system performance is checked daily by use of the echo box in conjunction with the indicator B-scope. The checks performed in this manner are the ringtime and AFC operation checks. These checks should be performed by maintenance personnel upon initial receipt of the equipment. The results obtained are entered in the radar log as a reference. The operator makes daily checks and enters the results of these checks in the radar log. A comparison of the daily readings with the initial test results will

show if the radar set is continuing to operate at peak efficiency or if the system effectiveness is decreasing. Because of the difficulty of obtaining a high degree of accuracy while ringtime is being measured, it is of the utmost importance that the measurements be made as carefully as possible and, preferably, by the same operator each day. The local oscillator must be properly tuned before the AFC and ringtime checks are performed.

a. Ringtime Check.

- (1) Turn on the radar set and elevate to minimize clutter on the B-scope.
- (2) Check the MAGNETRON CURRENT meter reading to assure a reading of 22 ma.
- (3) Set the indicator RANGE SELECTOR switch to the 10000 M position.
- (4) Turn the MARKERS switch to ON.
- (5) Tune the echo box until a peak reading is obtained on the relative power meter.
- (6) Rotate the EXPANDED SWEEP DELAY until the bright band covers the area where the noise on the B-scope starts to build up.
- (7) Set the RANGE SELECTOR to the 2500 M position.
- (8) Adjust IF GAIN for maximum ringtime display.
- (9) With the LOWER BEAM RANGE control, place the range strobe over the point where the noise starts to build up.
- (10) Read the RANGE counter to obtain the ringtime distance.
- (11) Record the ringtime distance, the relative power, and the transmitted frequency of the radar. Minimum acceptable ringtime is 650 meters.
- (12) Detune the echo box.
- (13) Return the RANGE SELECTOR switch to the 10000 M position.

b. Automatic Frequency Control Check.

- (1) Place the AFC-MANUAL switch in the MANUAL position.
- (2) Carefully tune the local oscillator for maximum intensity of range markers.
- (3) Change the AFC-MANUAL switch to AFC. There should be no noticeable change in marker intensity.
- (4) Check AFC operation by using the ringtime display. In this case, ringtime measured in AFC should not differ from ringtime measured in MANUAL by more than 50 meters.

23. Normal Stopping Procedure

a. Press the STOP button on the control-power supply panel. This turns the transmitter off.

b. To completely stop the radar, turn the MAIN POWER switch to the OFF position. The READY indicator lamp and MAIN POWER ON & INTLK CLOSED indicator lamp will go out.

c. To stop the power unit, hold the POWER UNIT switch in the STOP position until the engine *completely* stops. The POWER UNIT indicator lamp will go out.

24. Emergency Stopping Procedure

To stop the equipment in case of emergency, turn the MAIN POWER switch to OFF and hold the POWER UNIT switch to STOP until the engine completely stops. These two actions cut off all power to the radar.

25. Antenna Azimuth Orientation and Collimation

Orientation is the procedure of making the azimuth and elevation counters on the radar read correctly. It is an operator function. There are two methods of orienting the AN/MPQ-4A in azimuth—the *electrical* method and the *optical* method. The *electrical* method is preferred. There is no tolerance in azimuth orientation. *Orientation must be performed each time the set is emplaced and at least once a day while in position.* The set must be leveled prior to orientation. If the set has not been in operation at least 30 minutes before orientation is performed, orientation should be rechecked about 30 minutes after it is initially performed. The radar must be radiating, and the azimuth to the orienting point must be known. The orienting point must be well defined and separated far enough from other nearby targets to be easily identified. When the electrical method is used, the target must also be a good electrical target (return a strong echo to the radar). An aiming circle may be used when the optical method is used.

a. Azimuth Orientation (Electrical Method).

- (1) Rotate the antenna until it is pointed generally toward the orienting point. Move the antenna in elevation if necessary until the orienting point shows up as a target on the B-scope.
- (2) On the computer, set the DETENT switch to the OFF position, and place Δ AZIMUTH in detent.
- (3) Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe bisects the target (orienting point) on the B-scope.

Note. It may be necessary to adjust the IF GAIN to reduce the size of the echo so that it may be more easily bisected.

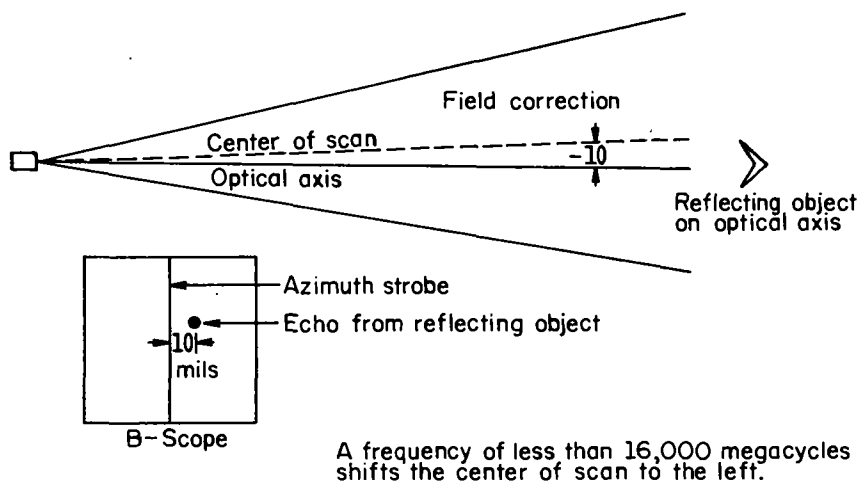
- (4) Hold the RADAR LOCATION AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter reads the azimuth to the orienting point.

b. Azimuth Collimation Check. The azimuth collimation check is the process of determining the horizontal angle between the center of scan (electrical axis) and the optical axis (orienting telescope) (fig. 17). This angle is caused by the transmitter frequency shifting above or below the nominal frequency (16,000 megacycles). As the frequency increases, the center of scan will shift to the right of the optical axis; as the frequency decreases, the center of scan will shift to the left. The horizontal angle between the optical axis and the center of scan caused by the frequency shift is called the field correction. This field correction can be determined by use of the tuned cavity (echo box) and a field correction table (fig. 18). With the DETENT switch in the AZIMUTH ORIENT position and Δ AZIMUTH and LOWER BEAM AZIMUTH controls in detent, the center of scan is represented by the azimuth strobe. Since the telescope (optical axis) is used in optical orientation and the azimuth strobe is used in locating weapons, the operator must insure that the optical axis and the azimuth strobe are separated by the amount of the field correction before optical orientation can be performed. The azimuth collimation check is performed as follows:

- (1) Determine the field correction. To determine the field correction.
 - (a) Turn the transmitter on and tune the echo box for maximum deflection of the meter needle.
 - (b) Read the frequency of the transmitter from the dial above the echo box tuning knob.
 - (c) Apply this frequency to the chart on the inside of the echo box cover, interpolating if necessary. The figure obtained is called the *field correction*.
- (2) Select any target which can be positively identified both on the B-scope and through the orienting telescope. This target can be improvised, if necessary, and should be at least 500 meters from the radar.
- (3) Move the radar in azimuth and elevation until the target is centered in the orienting telescope.

Note. Use the azimuth handwheel on the frame of the radar to move the set in azimuth. If the AZIMUTH switch on the control-indicator is used to move the antenna by small amounts, the brake and some of the relays in the azimuth system may be damaged.

- (4) Set the DETENT switch in AZIMUTH ORIENT, and place the Δ AZIMUTH and LOWER BEAM AZIMUTH handwheels in detent.
- (5) The azimuth strobe should be off the center of the echo on the B-scope by the amount of the field correction. The strobe is to the left of the echo if the correction is negative; to the right if the correction is positive. Verify the distance between the strobe and the center of the echo by noting the azimuth reading, placing the detent switch in the OFF position, moving the azimuth strobe over the center of the echo, and rereading the azimuth counter. The difference between the two readings should be numerically the same as the field correction.



A frequency of less than 16,000 megacycles shifts the center of scan to the left.

Figure 17. Collimation check.

c. *Azimuth Orientation (Optical Method)*. For the optical method of orientation, the orientation telescope is used to sight on the orienting point.

Note. Do not proceed with optical orientation unless correct results were obtained in azimuth collimation. If correct results were not obtained, have the radar mechanic correct the difficulty.

- (1) Position the antenna so that the *orienting point* is centered in the telescope (note, b(3) above).
- (2) Set the detent switch to the AZIMUTH ORIENT position, and place Δ AZIMUTH and LOWER BEAM AZIMUTH in detent.
- (3) Apply the field correction as indicated by its sign to the azimuth to the orienting point. A corrected azimuth is the result.

Example: Azimuth to orienting

point	(a) 1653	(b) 1653
Field correction	+4	-4
Corrected orienting	1657 mils	1649 mils

FREQUENCY	FIELD
16192	+12
16176	+11
16160	+10
16144	+9
16128	+8
16112	+7
16096	+6
16080	+5
16064	+4
16048	+3
16032	+2
16016	+1
16000	0
15984	-1
15968	-2
15952	-3
15936	-4
15920	-5
15904	-6
15888	-7
15872	-8
15856	-9
15840	-10
15824	-11
15808	-12

Figure 18. Frequency correction chart.

- (4) Hold the RADAR LOCATION AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter reads the *corrected* orienting azimuth.
- (5) Move the antenna in azimuth and elevation until a target echo which can be easily identified in the future is found. Read and record the azimuth and range to this target. This target can now be used as an electrical orienting point and can be used to check orientation during periods of poor visibility.

26. Elevation Orientation Check

An elevation orientation check is made to check the alinement of the orienting telescope with the elevation dials. Since there is no satisfactory means of checking the alinement of the telescope with the electrical beam at unit level, this check is of little value when the set is to be used for weapon location but is valuable for such other applications as high-burst registration of artillery. The checkpoint may be a fixed point of known elevation or a fire control instrument such as an aiming circle. To perform the elevation orientation check—

- a. Check the level of the set.
- b. Position the antenna so that the checkpoint is centered in the orienting telescope (note, par. 25b(3)).
- c. The elevation counter on the frame of the radar should indicate the correct elevation to the checkpoint. Record for future reference any error greater than 1 mil.

27. Computer Alinement Check

The purpose of the computer alinement check is to insure that the computer is providing correct locations. This check should be performed daily and after each move; it is performed as follows:

a. Check the linearity between the antenna elevation counter and the computer LOWER BEAM ELEVATION counter in the following manner:

- (1) Use the ELEVATION RAISE LOWER switch to position the antenna in elevation so that the following readings are obtained on the LOWER BEAM ELEVATION counter: —100, —50, 0, 50, 100, 150, 200 mils.
- (2) Check to see that the corresponding readings are obtained on the antenna counter. If the readings are not within 2 mils, notify the radar mechanic.

b. Check the azimuth controls and the B-scope indicator as follows:

- (1) Set the detent switch to OFF.
 - (2) Rotate the LOWER BEAM AZIMUTH control clockwise. The AZIMUTH counter reading *increases*, and the B-scope azimuth strobe moves to the right.
 - (3) Rotate the LOWER BEAM AZIMUTH control counterclockwise. The AZIMUTH counter reading *decreases*, and the strobe moves to the left.
 - (4) Set the DETENT switch to DETENT RELEASE and check to see that the two SET DETENT lights are on.
 - (5) Rotate the Δ AZIMUTH control clockwise. The AZIMUTH counter reading *decreases* and the strobe moves to the right.
 - (6) Rotate the Δ AZIMUTH control counterclockwise. The AZIMUTH counter reading *increases*, and the strobe moves to the left.
 - (7) If the set does not perform properly in all of the operations in (1) through (6) above, notify the radar mechanic.
- c. Check the range controls and the B-scope as follows:
- (1) Rotate the LOWER BEAM RANGE control clockwise. The RANGE counter reading *increases*, and the range strobe moves up.
 - (2) Rotate the LOWER BEAM RANGE control counterclockwise. The RANGE counter reading *decreases*, and the range strobe moves down.
 - (3) Rotate the Δ RANGE control clockwise. The RANGE counter reading *decreases*, and the range strobe moves up.
 - (4) Rotate the Δ RANGE control counterclockwise. The RANGE counter reading *increases*, and the range strobe moves down.
 - (5) If the set does not perform properly in all of the operations in (1) through (4) above, notify the radar mechanic.
 - (6) Move the DETENT switch to OFF and place Δ RANGE and AZIMUTH in detent.
- d. Check the RADAR HEIGHT counter by rotating its adjustment screw; note that the counter reading changes. The weapon HEIGHT counter reading should also change by the same amount. If it does not, notify the radar mechanic.
- e. Check the weapon HEIGHT counter by rotating the control knob; note that the reading changes on the weapon HEIGHT counter only. If the counter does not operate properly, notify the radar mechanic.

f. Check the RADAR LOCATION and WEAPON LOCATION counters as follows:

- (1) Hold the RADAR LOCATION EASTING switch in the SUBT position; both EASTING counter readings decrease.
- (2) Hold the RADAR LOCATION EASTING switch on the ADD position; both EASTING counter readings increase.
- (3) Repeat the steps in (1) and (2) above with the RADAR LOCATION NORTHING switch and counters.
- (4) If the switches do not work properly, notify the radar mechanic.

g. Check the linearity between the computer AZIMUTH counter reading and the movement of the azimuth strobe as follows:

- (1) With the radar set radiating, find an electrical target on the B-scope.
- (2) Set the computer DETENT switch to the OFF position and place Δ RANGE AND Δ AZIMUTH in detent.
- (3) Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe bisects the target on the B-scope. Note the reading on the AZIMUTH counter.
- (4) Actuate the AZIMUTH switch in the CW (clockwise) or CCW (counterclockwise) position to move the antenna in azimuth and to move the position of the target on the B-scope.
- (5) Rotate the LOWER BEAM AZIMUTH control until the strobe again bisects the target. The computer AZIMUTH counter should now read the same as before. If it does not, notify the radar mechanic.

h. Check the Δ TIME counter by rotating its control knob clockwise to increase its reading and counterclockwise to decrease its reading. If it does not operate properly, notify the radar mechanic.

i. When all of the components of the computer have been checked, check the accuracy of the computer.

- (1) The accuracy check consists of a series of four problems (fig. 19) which are set into the computer. These problems produce weapon locations which are compared against a set of answers. This set of answers or output data is determined by the radar mechanic for the particular set after he alines the computer. After alining the computer, the mechanic sets the beam separation to its normal position (correct setting is indicated on

Radar set ser no _____ Date of alignment _____ Aligned by _____ Beam separation _____

Computer ser no _____ Date of recorded output data _____ Recorded by _____

Problem na	Lower beam azimuth	Elevation	Lower beam range	Upper beam azimuth	Upper beam range	Time	Weapon height	Output data	
								Easting	Northing
1	0000	+ 20	8,000	0030	8,200	2.0	300		
2	1600	+ 40	5,000	1620	5,100	2.0	400		
3	3200	+ 10	8,000	3170	7,800	1.5	50		
4	4800	+ 40	5,000	4780	4,900	4.0	200		

Figure 19. Computer accuracy check.

the BEAM SEPARATION plate on the antenna). He then sets each of the four problems into the computer and records the weapon location easting and northing. These locations along with the problems are recorded in the radar log book.

- (2) Each day, or every time the set is moved, the operator will perform the accuracy check and compare his output data against the set of output data entered in the log by the mechanic. The tolerances for the check results versus the logged output data are as follows:
 - (a) The error in easting or northing shall not exceed 20 meters.
 - (b) The sum of the easting and northing errors shall not exceed 36 meters.
- (3) The results of the check will be entered in the log book.
- (4) The check will be performed by the operator as follows:
 - (a) Emplace the radar, apply power, and turn the transmitter on.
 - (b) Open the computer drawer and clock the INTERLOCK SHORT switch (fig. 20).

Note. This switch is located under a red cover in the top left-hand corner of computer compartment.

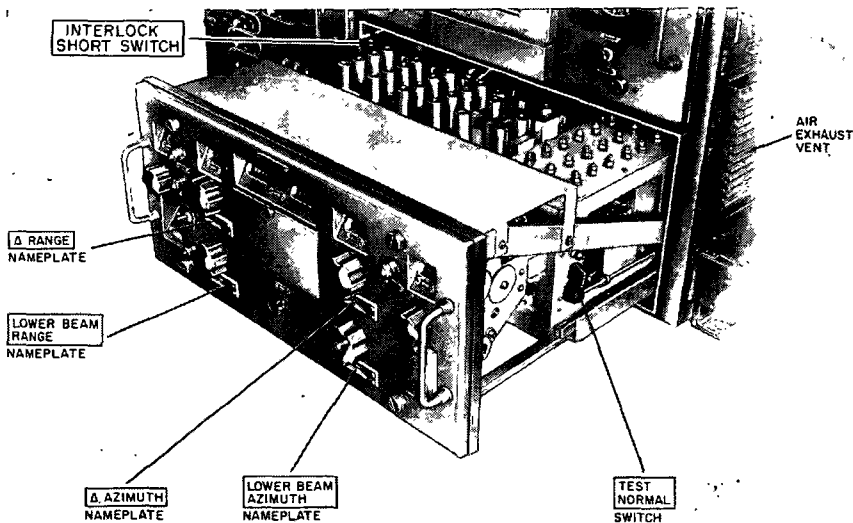


Figure 20. Part view of radar data computer.

- (c) Read the BEAM SEPARATION dial on left side of computer drawer (fig. 21). It must read the same as the BEAM SEPARATION plate on the antenna.

- (d) Set in the radar location data as follows:
 1. Use the EASTING and NORTHING switches to set the EASTING AND NORTHING counters to zero.
 2. Set the RADAR HEIGHT counter to 300 meters.
- (e) Set the radar on the proper angle of elevation.
- (f) Set the DETENT switch to OFF.
- (g) Place Δ RANGE and Δ AZIMUTH in detent.
- (h) Set in the proper azimuth, using the AZIMUTH switch and the LOWER BEAM AZIMUTH control.

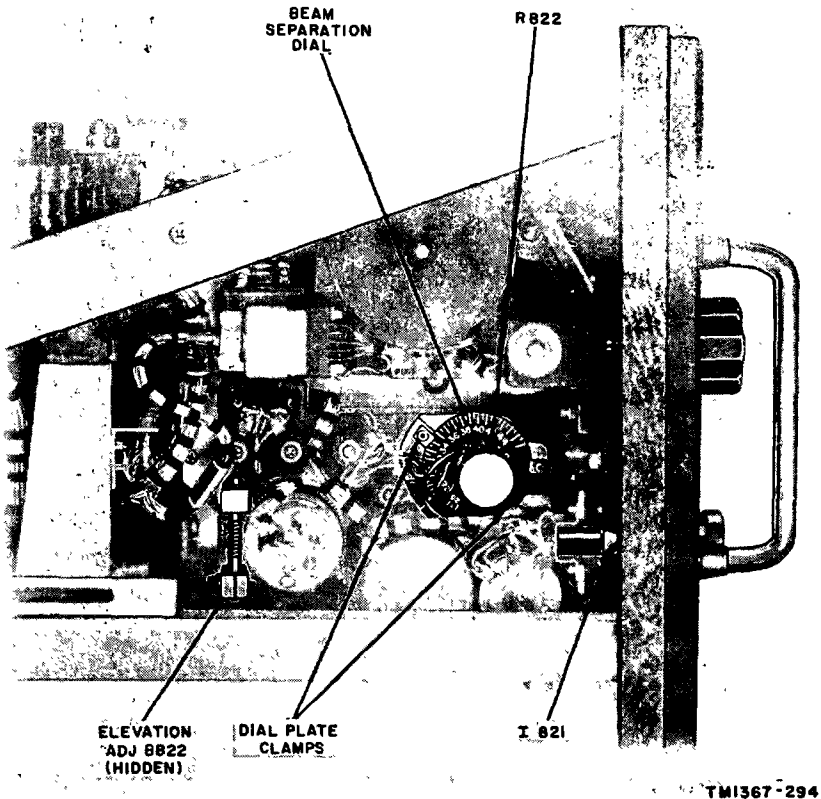


Figure 21. Beam separation dial on the computer.

- (i) Set in proper lower beam range.
- (j) Turn the TEST-NORMAL switch to TEST.
- (k) Set DETENT switch to DETENT RELEASE.
- (l) Set in upper beam azimuth with the Δ AZIMUTH control.
- (m) Set in upper beam range with Δ RANGE control.

- (n) Turn the TEST-NORMAL switch to NORMAL.
- (o) Set in the Δ time with the Δ TIME knob.
- (p) Set the weapon height into the computer.
- (q) Check the WEAPON LOCATION EASTING and NORTHING against the most recent set of output data entered in the radar log book by the mechanic.
- (r) Repeat the steps in (d) through (q) above for the remaining problems.
- (s) Compare this output data against the logged output data. If the answer to any problem is out of tolerance, notify the mechanic.

28. Radar Location Data

At the completion of the computer accuracy check, the true radar location is set into the computer.

a. Use the RADAR LOCATION EASTING and NORTHING switches to set the grid reference of the radar into the computer.

b. Use the RADAR HEIGHT knob to set the altitude of the radar in *meters* into the computer.

c. Normally the weapon HEIGHT counter is now set to read the same as the RADAR HEIGHT counter.

CHAPTER 6

WEAPON AND IMPACT LOCATION

Section I. PERSONNEL

29. General

A well-trained radar crew is essential to insure accurate, timely locations of hostile mortars. Continuous operation is required in a combat mission. It is imperative that each man in the section be capable of performing the duties that are necessary to obtain and process hostile weapon locations.

30. Utilization of Personnel for Operation

a. For continuous operation, the radar section must be organized into three-man teams, excluding the chief of section and the radar mechanic, who are on call continuously.

b. The duties of the three-man team are as follows:

- (1) *The radar operator* operates the radar and the computer, utilizing the controls on the control-indicator group.
- (2) *The chart operator* sets up the radar chart, determines the altitude of the weapon locations, plots the final locations, keeps the necessary records, and operates the communication equipment.
- (3) *The generator operator* operates and maintains the generator, provides local security, and assists the chart operator as necessary, during periods of intense enemy weapons activity.

c. The jobs of the personnel on duty should be rotated approximately every 30 minutes to give each person a change of jobs. When teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he comes on duty, since he would be working with two men who are familiar with the situation.

Section II. WEAPON LOCATION

31. General

The technique employed in locating mortars may be divided into two phases, the detection phase and the location phase. Both of these phases can be accomplished on one projectile.

32. Detection

a. A sector of search will be assigned to the radar. This sector of search will normally be the zone of action of the supported unit and, as such, will vary with the tactical situation. The radar should be sited for maximum observation of this assigned sector of search. Depending on the sector width and the location of the radar, the entire sector may be covered with one position of the radar antenna (445-mil beam width). The sector of search may be so large that the radar will be able to observe only a portion at any one time. In this instance, the radar should observe one portion for a short period of time and then observe another portion, continuing until the entire sector is covered.

b. When a weapon is fired so that the projectile passes through both beams of energy sent out by the radar set AN/MPQ-4A (fig. 22), the points at which the projectile intersects the two beams will be indicated by two bright spots on the B-scope. The elapsed time between the appearance of these echoes is measured by using the timer. The transparent cover over the B-scope is marked with a grease pencil to show the exact location of the intersection points on the B-scope. This cover is a reflection-type plotter, so designed that any mark made on the plotter will be reflected on the cathode ray tube inside. This feature eliminates error due to parallax between the echo on the cathode ray tube and the grease-pencil mark on the plotter. Careful adjustment of the PLOTTER DIMMER control is necessary to make the reflection easily visible. The grease-pencil marks are placed so

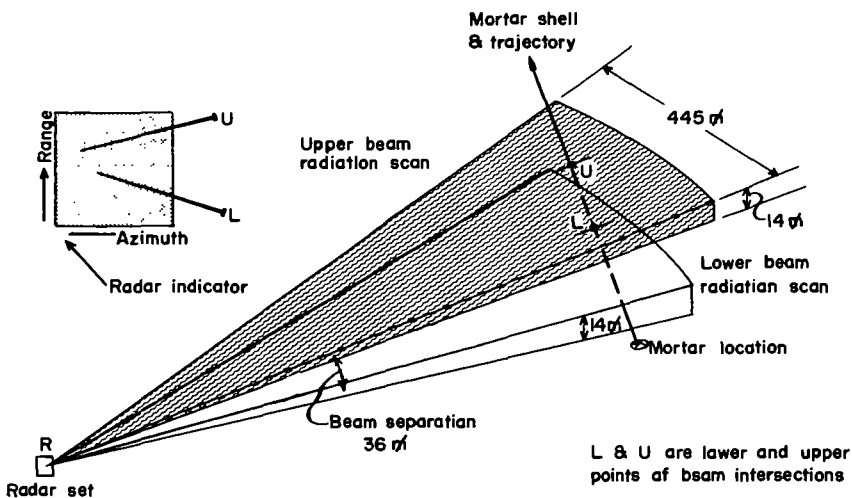


Figure 22. Scanning pattern for weapon location.

that their *reflections* are at the center of the echoes. These two operations, i.e., measuring elapsed time and marking the B-scope, constitute the detection phase of weapon location.

33. Operating Procedure

a. Press the AZIMUTH switch to CW (clockwise) or CCW (counterclockwise) position to rotate the antenna and cover any 445-mil sector of the expected target area. The scanner will sweep this 445-mil sector for targets.

b. Press the ELEVATION switch to RAISE or LOWER to position the reflector so that the elevation angle is 10 mils above the highest point on the screening crest. At this point, ground clutter should decrease to a minimum. (Use the telescope to determine the elevation angle for the top of the screening crest.)

c. When the projectile passes through the two beams, two indications of the target will appear on the screen a short interval apart (fig. 23). At the instant the first echo is seen on the B-scope, press either of the two TIMER buttons to start the SECONDS clock and mark the presentation with a grease pencil. When the second echo appears, press either TIMER button again to stop the clock and mark the second presentation. The elapsed time between echoes appears on the clock.

Note. The RANGE SHIFT switch should be in the ON position so that the video display of the upper and lower beams will be displaced.

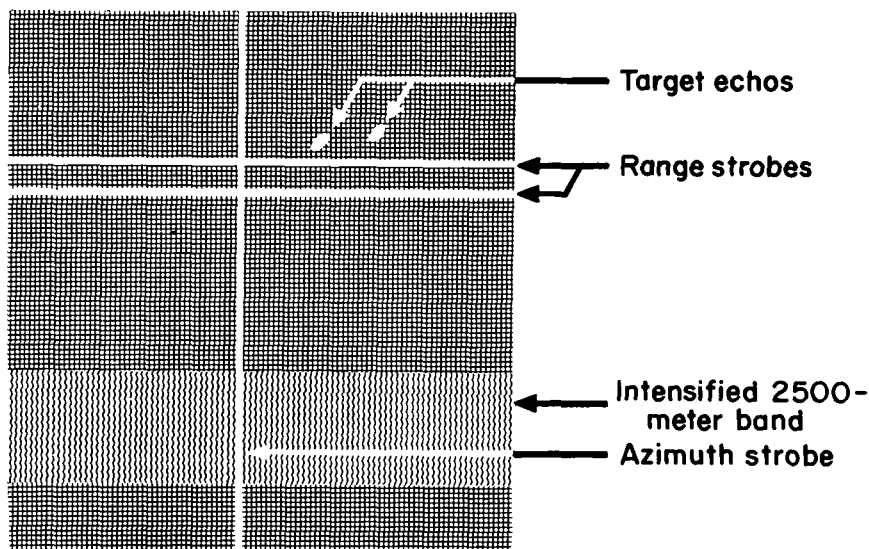


Figure 23. B-scope presentation (10,000-meter range sweep).

34. Location

By positioning the lower beam azimuth and lower beam range strobes over the first echo and then placing the switch in DETENT RELEASE and the Δ AZIMUTH AND Δ RANGE strobes over the second echo, with the Δ TIME value inserted, the coordinates of the weapon will appear on the computer if the radar and the weapon are at the same altitude.

35. Corrections for Difference in Altitude

If, after plotting a weapon location on a contour map, it is determined that the plotted point is at a different altitude than the radar, set the altitude of the plotted point on the weapon HEIGHT counter. This action may change the weapon location coordinates. If a change greater than 10 meters is made, the new weapon location should be replotted and its altitude determined. This procedure should be repeated until the difference between successive altitude readings is 10 meters or less.

36. Computing Weapon Location

a. Place the detent switch in OFF position and Δ RANGE and Δ AZIMUTH in detent. Turn the LOWER BEAM RANGE control, on the computer, until the lower range strobe intersects the first (lower beam) echo on the B-scope (fig. 24).

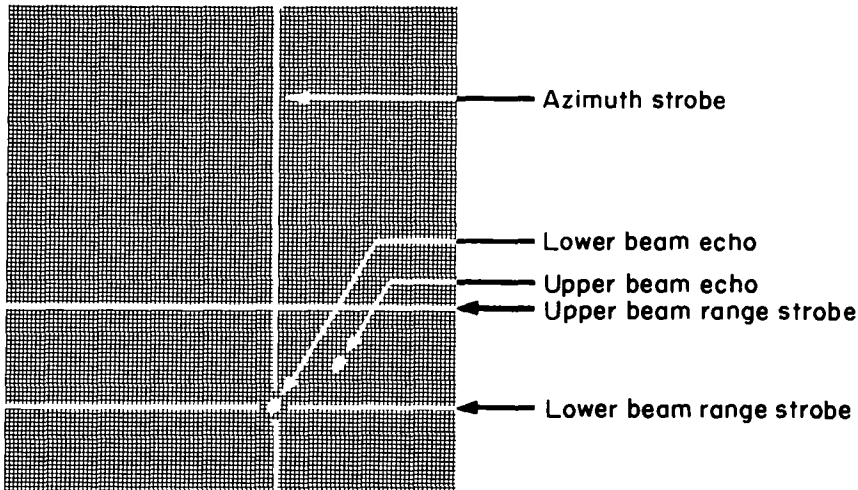


Figure 24. Stroboscopic display of radar echoes (2,500-meter range presentation).

b. Turn the LOWER BEAM AZIMUTH control until the azimuth strobe intersects the lower beam echo.

c. Place the detent switch in the DETENT RELEASE position.

d. Rotate the Δ RANGE control until the upper range strobe intersects the second (upper beam) echo on the B-scope (fig. 25).

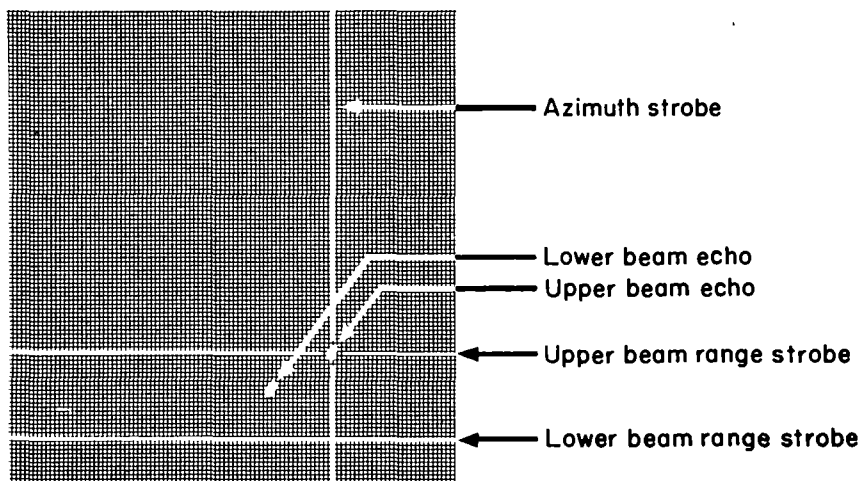


Figure 25. Strobing the upper echo (2,500-meter range presentation).

e. Rotate the Δ AZIMUTH control until the azimuth strobe intersects the upper beam echo.

f. Rotate the Δ TIME control until the time lapse between the appearance of the two echoes appears on the counter.

g. Read the WEAPON LOCATION EASTING and NORTH-ING counters to obtain the uncorrected grid coordinates of the weapon. The uncorrected polar coordinates of the weapon may be read from the RANGE and AZIMUTH counters.

h. Plot the first location of the weapon on a contour map and compare the altitude of the plot to the altitude of the radar. If the two differ by more than 10 meters, the map altitude of the plot is set into the WEAPON HEIGHT counter on the computer. This may change the weapon location coordinates. In case of a significant change, the new location is plotted and a new altitude is obtained. This new altitude is compared to the altitude of the first plot. If the two altitudes differ by more than 10 meters, the second map plot altitude is set into the computer. This procedure of replotting is continued until two successive altitude readings are within 10 meters or until there is no significant change in the weapon location.

Example: The two echoes have been strobed and Δ TIME has been set into the computer.

(1) First uncorrected weapon location	5462035290
Altitude of first plot	285 meters
Altitude of radar	196 meters

The altitude of the radar and weapon differs by more than 10 meters so the first plot altitude is set on the weapon HEIGHT counter.

- (2) Second uncorrected weapon location 5455035310

The first plot altitude made a significant change in the weapon location, so the second weapon location is plotted. A new altitude is obtained.

- (3) Second plot altitude 290 meters

The second plot altitude is within 10 meters of the first plot, making the second weapon location the correct one.

i. Make certain that the DOUBTFUL SOLUTION indicator lamp is not on.

j. Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters to obtain the location of the weapon position.

k. Place the detent switch in the OFF position.

l. Reset the Δ RANGE and Δ AZIMUTH controls to their detent position.

m. On the indicator, press the RESET switch to return the SECONDS clock to zero.

n. The radar equipment is now ready for the next problem.

o. If the RANGE SELECTOR switch is in the 10,000 meter position, set the EXPANDED SWEEP DELAY switch so that the bright band on the B-scope incloses the approximate position of the target. This is shown in figure 26. Turn the LOWER

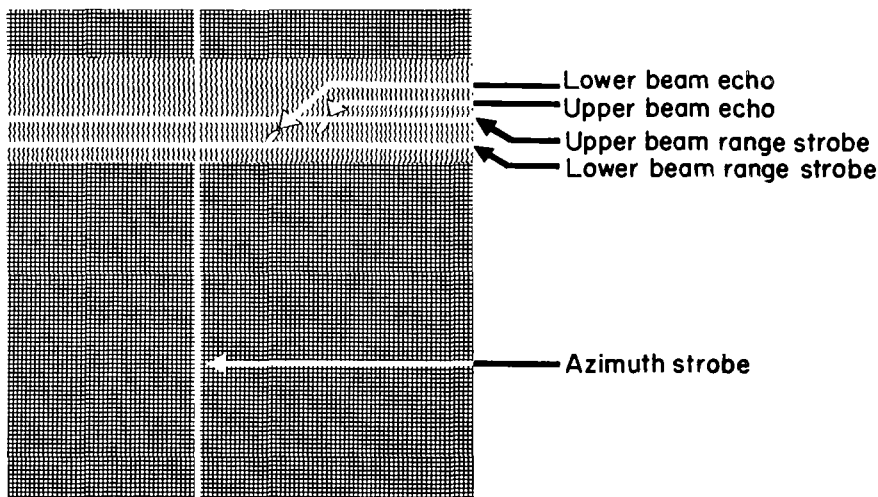


Figure 26. 2,500-meter bright band over the point where the echoes appeared.

BEAM RANGE control on the computer to set the range strobes within the bright band. To expand the bright band over the entire area of the screen, turn the RANGE SELECTOR switch to 2500 M (fig. 27). (If the approximate position is previously known, it will be possible for the operator to have expanded the sweep before the target appears on the screen.)

Note. The operator should keep in mind that as the angle of elevation of the lower beam increases, the Δ TIME factor becomes much more important (fig. 28).

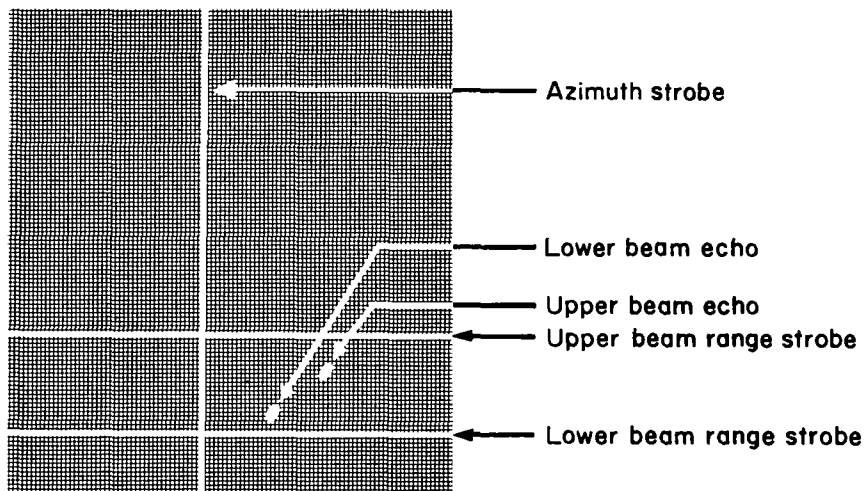


Figure 27. Echo presentation of a subsequent round with the 2,500-meter range sweep.

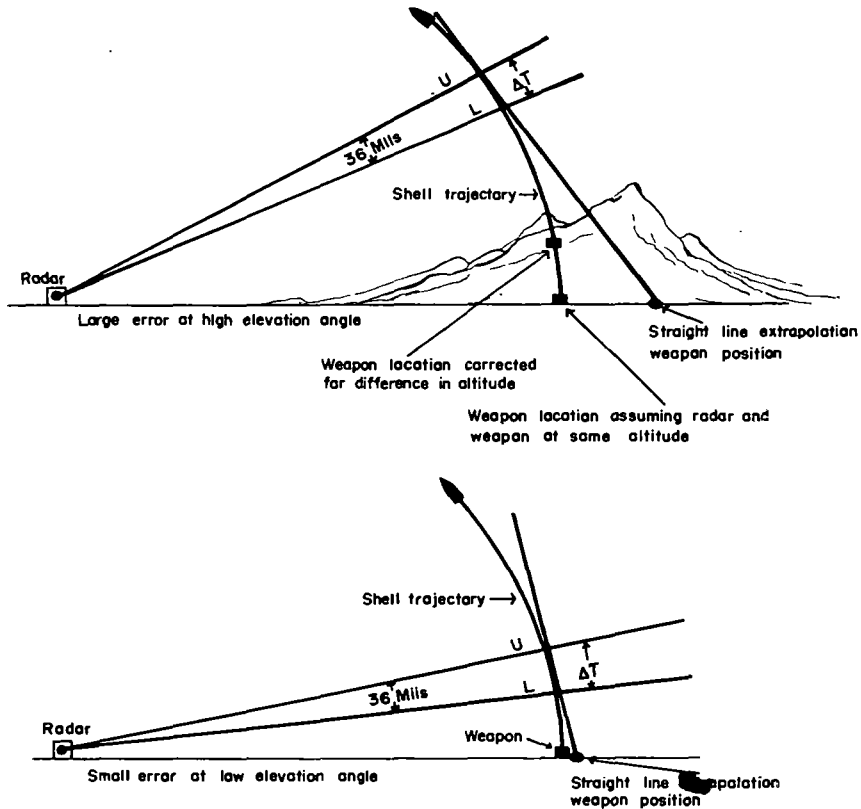


Figure 28. Effect on the weapon location of ΔT and differences in altitude corrections.

Section III. IMPACT LOCATION

37. General

Radar set AN/MPQ-4A may be used to compute the impact location of outgoing (friendly) mortar and high-angle artillery rounds. The observed presentation will be identical with the scope pattern in figure 23 or 27, except that the projectile will be moving downward and the upper beam echo will appear on the B-scope first.

38. Computing Impact Location

- Rotate the LOWER BEAM RANGE control until the lower range strobe intersects the second (lower beam) echo on the B-scope.
- Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe intersects the lower beam echo.

- c. Set the detent switch to DETENT RELEASE.
- d. Rotate the Δ RANGE control until the upper range strobe intersects the first (upper beam) echo on the B-scope.
- e. Rotate the Δ AZIMUTH control until the azimuth strobe intersects the first (upper beam) echo.
- f. Rotate the Δ TIME control until the time lapse between the appearance of the two echoes appears on the counter.
- g. Read WEAPON LOCATION EASTING and NORTHING counters to obtain the uncorrected grid coordinates of the impact. Uncorrected polar coordinates of the impact may be read on the RANGE and AZIMUTH counters.
- h. Plot the uncorrected location on a contour map. If the altitude of the impact differs from that of the radar site, set the map altitude on the weapon HEIGHT counter. This action may change the impact location coordinates. If a significant change is made in the impact location, the new location should be re-plotted and a new altitude set into the computer. This procedure should be repeated until the difference between successive altitude readings is no greater than 10 meters (example, par. 36).
- i. Make sure that the DOUBTFUL SOLUTION indicator lamp is not lighted.
- j. Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters for the location of the impact area.
- k. Place the detent switch in the OFF position.
- l. Reset the Δ RANGE and Δ AZIMUTH controls to their detent positions.
- m. On the indicator, press the RESET switch to return the SECONDS clock to zero.
- n. The radar equipment is now ready for the next problem.

CHAPTER 7

RADAR GUNNERY

Section I. RADAR-OBSERVED HIGH-BURST REGISTRATION

39. General

The AN/MPQ-4A radar was designed to be employed in the countermortar role, and its primary purpose is the location of hostile mortars. However, the capabilities of the radar are such that it may profitably be employed in observing high-burst (HB) and center-of-impact (CI) registrations. When the proper techniques and procedures are employed, the accuracy of the registration corrections obtained by radar-observed methods is comparable to that of corrections determined by more conventional methods.

40. Purpose of High-Burst Registrations

The purpose of a high-burst registration is to obtain corrections for nonstandard conditions. The values of elevation and fuze setting listed in the firing table for a given range and charge are based on standard conditions for air density, air temperature, powder temperature, projectile weight, and wind. If standard conditions do not exist at the time of firing, a projectile fired with a certain charge and elevation will not burst at the range given in the firing table. Further deviations may be expected due to different ammunition lots, variations from standard in muzzle velocities of the guns, and errors in survey and chart construction. From a valid high-burst registration, corrections in deflection (azimuth), fuze setting (time), and elevation are determined at the fire direction center (FDC) (FM 6-40) to place the mean burst location of rounds fired at a predetermined point.

41. Selection of Registration Point

a. The selection of a high-burst registration point must be coordinated between the fire direction center (FDC) and the radar section. For the FDC to obtain the most valid and usable corrections, the registration point must be located in the area in which it is anticipated that fire for effect will be needed or in an area for which FDC does not already have valid corrections. The registration must be fired with the charge that FDC expects

to use on later fire missions in the area. If the registering piece is a howitzer, the site to the burst, measured at the piece, should not exceed 50 mils. A smaller site is preferred to obtain more valid corrections.

b. The registration point must be visible from the radar. In order to read elevation deviations below as well as above the registration point, the pointing elevation of the radar should be at least 10 mils above the radar screening crest at the azimuth to the registration point. For tactical and technical reasons the radar screening crest should be at least 15 mils in angle of elevation (angle of site) from the radar.

c. The selected registration point will be designated to the radar by grid coordinates and altitude. Radar pointing data (azimuth, elevation, and range) are computed to place the radar beam and optical telescope on the registration point. As each round bursts, its deviation from the radar pointing azimuth and elevation is read in mils on the optical telescope, and its azimuth and range are read on the radar B-scope. Observations are taken for six usable rounds, as determined by the radar officer in conjunction with the fire direction center, and the center of bursts is computed. Coordinates and altitude of the center of bursts are determined and sent to the fire direction center where registration corrections are computed.

42. Preparation of Radar

a. If the radar is properly sited to fulfill its countermortar role, it is properly sited for its secondary role of radar gunnery. For a valid registration, the angle of elevation to the screening crest should not exceed 40 mils. If the angle of elevation to the screening crest is small, the registration point can be selected at a low altitude, and, in general, the registration will be more valid. However, the screening crest angle of elevation should be at least 15 mils to reduce ground clutter to a minimum and to offer some tactical advantages of defilade.

b. The relative locations of the radar and gun must be known. This information may be obtained from survey, or the radar may be moved to the vicinity of the registering piece.

c. The radar must be leveled. Cross-level of the radar must be checked closely. A comparison of the reading on the elevation counter of the computer and the reading on the elevation indicator on the frame of the radar is made. If the two readings differ, the reading on the elevation indicator mounted on the frame of the radar is taken as the true elevation of the radar.

d. The radar must be oriented and range calibrated. Elevation orientation should be checked.

e. The radar must be systems checked.

Note. Orientation and range calibration should be checked immediately prior to conducting the registration.

f. Computer alinement checks must be made.

43. Preliminary Procedure

a. Determine pointing data.

- (1) Pointing data may be determined either by radar personnel or the registering FDC.
- (2) When the radar is located at the gun, pointing azimuth for radar is the same as the azimuth fired by the gun. Elevation for the radar is the same as the site fired by the gun. Range is the range corresponding to the time (fuze setting) fired.
- (3) When the radar is not located at the gun, pointing data are determined by plotting. On a 1:50,000-scale grid sheet or battlemap, the locations of both radar and registration point are plotted, and the altitudes of both are determined. The pointing azimuth and range are measured directly, and, by use of the mil relationship, pointing elevation is determined.
- (4) The pointing elevation (height of the high-burst registration point above the radar screening crest) at the pointing azimuth is determined by means of the screening crest profile. It should be at least 10 mils to obtain the most valid corrections (par. 41b). If the pointing elevation is less than 10 mils FDC must be notified and requested to increase the altitude of the high-burst registration point. If the pointing elevation is appreciably greater than 10 mils above the screening point, FDC should be notified and requested to decrease the altitude of the registration point to approximately 10 mils.
- (5) The radar officer obtains the probable error in height of burst either from the firing tables or from FDC. He determines the angular deviation of four probable errors in height of burst, as seen from the radar. He instructs the radar observers that any rounds deviating in elevation more than four probable errors from the mean elevation of the bursts are invalid and these rounds will not be used for the registration.

b. Place the BEAM VIDEO switch in the LOWER position, and the RANGE SHIFT switch in the OFF position. This will

remove the upper beam video and strobe from the B-scope. The lower beam only is used for all observations.

c. Place the location of the radar in easting, northing, and altitude into the RADAR LOCATION and RADAR HEIGHT sections of the computer. Place the altitude of the high-burst registration point into the weapon HEIGHT section of the computer.

d. Set the detent switch to OFF, and insure that the Δ AZIMUTH and Δ RANGE controls are in detent.

e. Set off pointing data on the radar.

(1) Set the detent switch in AZIMUTH ORIENT and place the LOWER BEAM AZIMUTH control in detent. Place the azimuth handwheel (on the trailer frame) in the middle position, and manually rotate the antenna to the approximate pointing azimuth. Place the azimuth handwheel (on the trailer frame) in the IN position, and, with the handwheel, make any fine adjustments necessary to place the antenna on the pointing azimuth (nearest 5 mils).

(2) With the ELEVATION switch, move the antenna to the pointing elevation (nearest 5 mils). Read the elevation on the elevation indicator mounted on the frame of the radar.

(3) Place the RANGE SELECTOR switch in the 2500 M position and the EXPANDED SWEEP DELAY switch in the appropriate position for the pointing range.

f. With the LOWER BEAM AZIMUTH and LOWER BEAM RANGE controls, move the azimuth and range strobes off the expected point of burst on the B-scope.

g. Station an observer at the orienting telescope to read azimuth and elevation deviations of the bursts.

h. Station an operator at the B-scope to read azimuths and ranges to the bursts.

i. Report "Ready to observe" to FDC.

44. Conduct of Registration

a. As each round is fired, FDC notifies the radar operator "On the way." The observer stationed at the orienting telescope observes the bursts in the telescope and reads their deviations in azimuth and elevation from the center of the telescope. He reads first the azimuth deviation and then the elevation deviation to the nearest mil and reports these deviations in this order to the recorder; for example, 12 RIGHT, 4 BELOW. If either

azimuth or elevation deviation of the first burst exceeds 10 mils, the recorder will move the radar antenna the amount of the deviations in azimuth and elevation to point the antenna where the first burst occurred. There will be no further movement of the antenna; all succeeding bursts will be read as they appear in the orienting telescope.

b. The round appears on the B-scope as an echo and will move out in range (fig. 29). The B-scope operator follows the moving echo with a sharpened grease pencil. When the round bursts, its echo on the scope will stop and "blossom." The operator marks the center of the "blossom" with a small trace of the grease pencil (fig. 30).

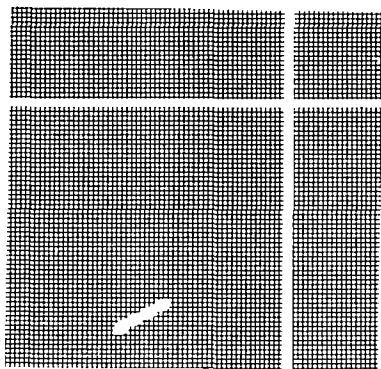


Figure 29. Projectile first entering the beam (HB).

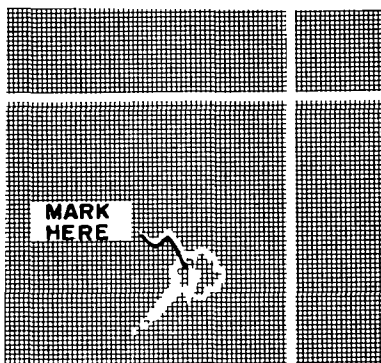


Figure 30. Projectile bursting in the beam (HB).

c. With the LOWER BEAM AZIMUTH and LOWER BEAM RANGE controls, the operator places the azimuth and range strobes at the point marked by the grease pencil (fig. 31).

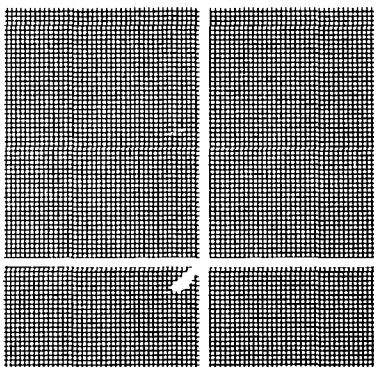


Figure 31. Stroboscopic of marked burst (HB).

d. The operator reads the azimuth and range to the burst on the AZIMUTH and RANGE counters and reports them to the recorder in that order.

e. The recorder records the readings, using DA Form 6-39 changed for use with the AN/MPQ-4A (fig. 32). Changes will be made at the time data is entered on the form.

f. The radar operator notified FDC when he has six sets of usable observations. The recorder averages the azimuth readings from the B-scope to obtain the azimuth to the center of bursts, which has been determined electrically. He averages the azimuth deviations taken from the orienting telescope and applies that average to the pointing azimuth; then he strips out the field correction to determine an optical azimuth to center the bursts. The electrical and optical azimuths should be the same. If there is any difference, the decision as to which result to use will depend on the state of training of the observers.

g. The recorder averages the elevation deviations observed in the orienting telescope to obtain an average deviation. The average elevation deviation is applied to the radar pointing elevation to determine the elevation to center of bursts.

h. The recorder determines arithmetically range observations taken from the B-scope to obtain the range to the center of bursts.

i. The B-scope operator insures that the detent switch is in the OFF position and that the Δ AZIMUTH and Δ RANGE controls are positioned in detent. If either of these controls has been moved, the registration is invalid.

j. The azimuth and range to the center of bursts are placed on the AZIMUTH and RANGE counters by means of the LOWER BEAM AZIMUTH and LOWER BEAM RANGE controls respectively. The coordinates of the center of bursts are read di-

RADAR-OBSERVED HIGH-BURST REGISTRATION (FM 6-160)						
POINTING DATA						
RANGE (m) (Nearest 10 m)	TELESCOPE	AZIMUTH (m) (Nearest 5 m)		ELEVATION (m) (Nearest 5 m)		
3220 M	280 M	280 M		+35 M		
ROUND	SCOPE	TELESCOPE		ELEVATION/ABOVE	ELEVATION/BELOW	RANGE
	AZIMUTH/ABOVE	RIGHT	LEFT			
1	274		9	8		3180
2	273		7	1		3090
3	288	6		4		3170
4	279		1		4	3210
5	280		4	3		3120
6	287	3			3	3150
TOTAL	1681	9	21	16	7	18920
ALGEBRAIC TOTAL	XXXX	12L		9	-	
AVERAGE	280.2	2L		1.5	-	3153
POINTING AZIMUTH	XXXX	XXXX				
AZIMUTH TO HIGH BURST	280					
POINTING ELEVATION				+35	-	
ELEVATION TO HIGH BURST				+37	-	
RANGE TO HIGH BURST						3150

POLAR PLOT DATA FOR HIGH BURST		
POINTING AZ	<u>280</u>	
LESS FIELD CORRECTION	<u>-(-2)</u>	
TELESCOPE POINTING AZ	<u>282</u>	3.15
AVERAGE AZ DEVIATION	<u>2L</u>	+37
TELESCOPE AZ TO HB	<u>280</u>	2205
		945
		+116.55

To FDC: COOR 62981 37927 ALT. 380M

HT ABOVE RADAR = $EL \times RN = +37 \times 3.15 = +117 M$

ALT OF HB = 263

+117

380M

DA FORM 6-39

Figure 32. Modified Form DA 6-39.

rectly on the EASTING and NORTHING counters of the weapon LOCATION section of the computer.

k. The elevation and range to the center of bursts and the mil relationship are used to determine the height of the center of bursts above the radar in meters. The altitude of the center of bursts is obtained by adding the altitude of the radar to the height of the center of bursts above or below the radar.

l. The location of the center of bursts is plotted on the radar chart by polar data as a check on the coordinates produced by the AN/MPQ-4A computer.

m. The coordinates and altitude of the center of bursts are then sent to the FDC.

45. Advantages and Disadvantages

a. *Advantages.* Advantages of the radar method for high-burst registration over other methods are—

- (1) Less survey, communications, and coordination are required.
- (2) Fewer personnel are required.
- (3) More rapid.
- (4) Effective at greater ranges (unlimited by the length of the 01-02 base).

b. *Disadvantages.* Disadvantages of the radar method for high-burst registration are—

- (1) The bursts must be visible at the radar. This requirement limits position areas for the radar, particularly in mountainous terrain.
- (2) Requires some knowledge of gunnery by radar personnel and some knowledge of radar by FDC personnel.

46. Illustrative Problem: Radar-Observed High-Burst Registration (Fig. 32)

a. *Situation.* Battery A, 1st How Bn, 17th Arty, will fire a high-burst registration. Your radar section has been ordered to observe the registration. FDC has given you the following information:

- (1) Location of registering piece is 5959834562, altitude 201 meters.
- (2) Location of HB registration point is 6300038000, altitude 369 meters.
- (3) Location of your radar is 6212634895, altitude 263 meters (antenna altitude).
- (4) Your screening crest angle is +23 mils.

b. *Required.*

- (1) Polar plot data to center of bursts.
- (2) Coordinates and altitude of center of bursts.

c. *Solution.*

- (1) Radar pointing data.
Azimuth 280 mils (nearest 5 mils)
Elevation +35 mils (nearest 5 mils)
Range 3,220 meters (nearest 10 meters)

- (2) Pointing data were set on the radar, and the registration was fired. The following observations were made at the radar:

<i>Azimuth</i>		<i>Elevation</i>	<i>Range</i>
(B-scope)	(Telescope)	(Telescope)	(B-scope)
280	9L	8 above	3,180
278	7L	1 above	3,090
283	6R	4 above	3,170
279	1L	4 below	3,210
280	4L	3 above	3,120
281	3R	3 below	3,150

The field correction was found to be —2 mils.

- (a) *Determine polar data to center of burst.*

Azimuth 280 mils (nearest mil)

Elevation +37 mils (nearest mil)

Range 3,150 meters (nearest 10 meters)

- (b) *Determine coordinates and altitude of center of bursts.*

1. The coordinates of the center of bursts are obtained from the computer using the procedure described in paragraph 44. They are 6298137927.
2. The altitude of the center of burst is determined by means of the mil relation. It is 380 meters.
3. The coordinates and altitude of the center of bursts are sent to FDC.

Section II. RADAR-OBSERVED CENTER-OF-IMPACT REGISTRATION

47. General

By means of a center-of-impact registration, FDC obtains corrections in deflection and elevation but cannot determine time corrections (par. 40).

48. Selection of Registration Point

The considerations applicable to the selection of a high-burst registration point are equally applicable to the selection of a center-of-impact registration point except that the center-of-impact registration point need not be visible from the radar (par. 41).

49. Preparation of Radar

Preparation of the radar for a center-of-impact registration is the same as for the high-burst registration (par. 42).

50. Preliminary Procedure

a. Determine pointing data. Because of the effective width of the radar beam in azimuth and the display of 2,500 meters of range on the B-scope, approximate pointing data in azimuth and range are sufficient. These data are determined in the same manner as for a high-burst registration (par. 43).

b. Pointing elevation for the radar will be the angle of site to the screening crest (at the pointing azimuth) plus 10 mils (fig. 33).

c. The remaining steps in the preliminary procedure are the same as those for a high-burst registration (par. 43).

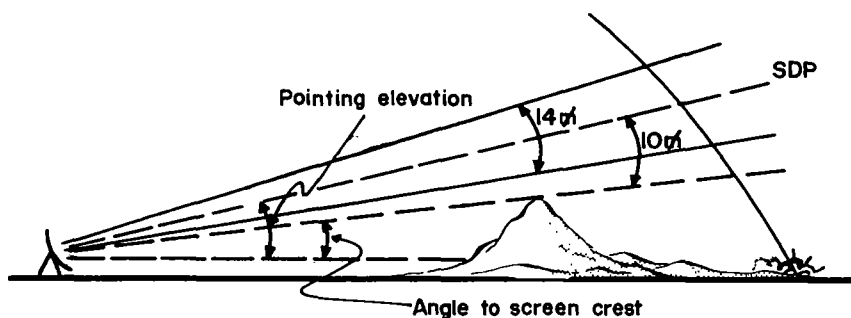


Figure 33. Side view of selected datum plane.

51. Conduct of the Registration

a. As each round is fired, FDC notifies the radar operator "On the way." The round will appear on the B-scope and will move out in range in a series of "blips" as the round passes through the radar beam (fig. 34). (Depending on the setting of the scope controls, the round may appear as practically a continuous line on the B-scope.) With a sharpened grease pencil, the operator marks on the face of the scope the first and last "blips" to appear (fig. 35). Care must be taken to avoid including the echo from the ground burst in the marked area. The operator marks with light, thin, vertical lines. The point midway between the two marks represents the azimuth and range at which the projectile passed through the center of the radar beam. That point is marked with the grease pencil (fig. 36).

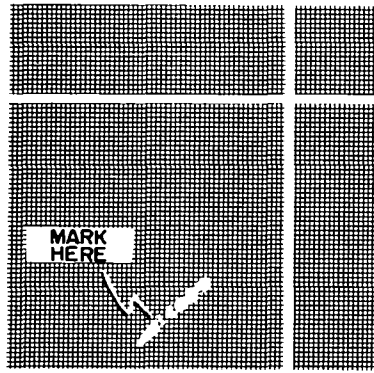


Figure 34. Marking where projectile enters the beam (CI).

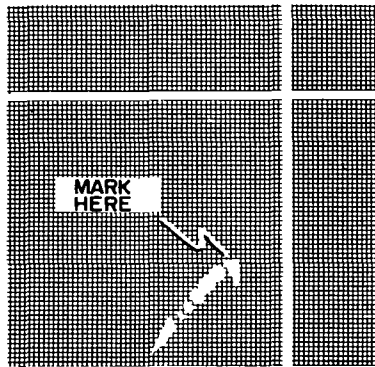


Figure 35. Marking where projectile leaves the beam (CI).

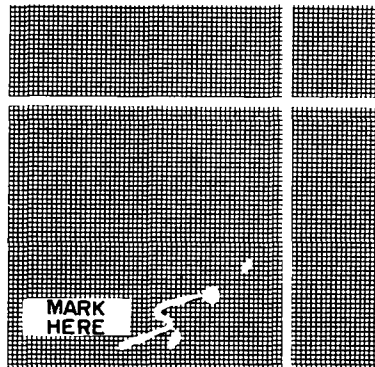


Figure 36. Marking the point where the projectile passed through the center of the beam.

b. With the LOWER BEAM AZIMUTH and LOWER BEAM RANGE controls, the operator places the azimuth and range strobe at the midpoint marked by the grease pencil (fig. 37).

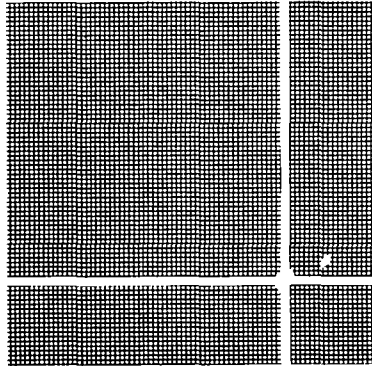


Figure 37. Strobings the midpoint.

c. The B-scope operator reads the azimuth and range on the AZIMUTH and RANGE counters, and the recorder records the readings, using DA Form 6-40 changed for use with the AN/MPQ-4A (fig. 38). Changes will be made at the time data is entered on the form.

d. Steps in *a* through *c* above are repeated until the recorder has six usable readings in range and azimuth. When he has six usable readings in range and azimuth, he reports these readings to the FDC.

e. The recorder averages the azimuth and range readings obtained in steps *a* through *d* above, to determine an azimuth and range to the center of the area in the selected datum plane (SDP) through which the rounds passed. The angle of elevation to this center point is the angle of elevation of the SDP and the pointing elevation of the radar.

f. The B-scope operator insures that the detent switch is in the OFF position and that the Δ AZIMUTH and Δ RANGE controls are positioned in detent.

g. The azimuth and range to the center of rounds in the SDP are placed into the computer in the same manner as that for a high-burst registration, and coordinates of the center of rounds are determined (par. 44).

52. Advantages and Disadvantages

a. *Advantages.* Advantages of the radar method for center-of-impact registration are—

- (1) The advantages listed in paragraph 45 for the high-burst registration apply for the center-of-impact registration.
- (2) The use of radar in a center-of-impact registration has the additional advantage that such a registration can be conducted during periods of poor visibility and in areas in defilade to visual observers.

RADAR-OBSERVED CENTER-OF-IMPACT REGISTRATION (FM 6-160)							
GUN DATA TO PICK-UP POINT (Pick-up point is on gun - CI line)							
RADAR POINTING DATA							
Az 190 M EL +35 M RN 3990 M							
ROUND NUMBER	1	2	3	4	5	6	
LOWEST HEIGHT TRACKED (FI)	X	X	X	X	X	X	X
LOWEST HEIGHT TRACKED COMMON TO ALL ROUNDS (FI)			HEIGHT OF SELECTED DATUM PLANE TO NEXT HIGHER 100' (FI)				
ROUND	RANGE SELECTED DATUM PLANE		AZIMUTH SELECTED DATUM PLANE		SELECTED DATUM PLANE ELEVATION DATUM PLANE OF SELECTED		
1	3790		168		+35 M		
2	3800		165		ZERO HEIGHT DECREASING CORRECTION (FI) X TRUE HEIGHT OF SELECTED DATUM PLANE (FI) or (FI)		
3	3760		169				
4	3770		167				
5	3760		166				
6	3780		165		ALTITUDE OF RADAR FI M 132		
TOTAL	22660		1000		ALTITUDE OF CI M 264		
AVERAGE COORDINATES	3777		167 M				
61871 37808 3780 M 3.78 35 1890 1134 132.30							
$1st\ above\ rd = el \times rn = +35 \times 3.78 = 132M$ $act\ of\ CI = 132 + 132 = 264M$							
To FDC: COOR 61871 37808 act 264 M							

DA FORM 6-40
1 NOV 55

Figure 38. Modified DA Form 6-40.

b. Disadvantages. Disadvantages of the radar method for center-of-impact registration are—

- (1) Screening crest requirements limit the position areas for the radar, particularly in mountainous terrain.
- (2) Requires some knowledge of gunnery by radar personnel and some knowledge of radar by FDC personnel.

53. Illustrative Problem: Radar-Observed Center-of-Impact Registration

a. Situation. Battery A, 1st How Bn, 17th Arty, will fire a center-of-impact registration. Your radar section has been ordered to observe the registration. FDC has given you the following information:

- (1) Location of CI registration point is 6200038000, altitude 157 meters.
- (2) Location of your radar is 6125534082, altitude (antenna) 132 meters.
- (3) Your screening crest angle is +27 mils.

b. Required.

- (1) Polar plot data to center of bursts.
- (2) Coordinates and altitude of center of bursts.

c. Solution.

- (1) Pointing data is—

Azimuth 190 mils (nearest 5 mils).
Elevation +35 mils (nearest 5 mils).
Range 3,990 meters (nearest 10 meters).

- (2) Pointing data were set on the radar, and the registration was fired. The following observations were made at the radar:

<i>Azimuth</i>	<i>Range</i>
168.....	3,790
165.....	3,800
169.....	3,760
167.....	3,770
166.....	3,760
165.....	3,780

Polar data to center of rounds is—

Azimuth 167 mils
Elevation +35 mils
Range 3,780 meters.

- (3) Determine coordinates and altitude of center of rounds (average point of intersection of trajectory and radar beam).

- (a) The coordinates of the center of rounds are obtained from the computer by using the procedure described in paragraph 43. The coordinates are 6187137808.
- (b) The altitude of the center of rounds is determined by means of the mil relationship. The altitude is 264 meters.
- (c) The coordinates and altitude of the center of rounds are sent to FDC.

Section III. RADAR ADJUSTMENT OF ARTILLERY FIRE

54. General

When survey control is lacking or if no agency is available to observe, the AN/MPQ-4A radar can be used to adjust low-angle friendly artillery fire, provided the angle of fall is large enough that the extrapolation capabilities of the computer will not be exceeded.

55. Procedures

a. Siting and preparation of the radar for fire adjustment are the same as for weapon location.

b. The location of the burst is obtained by marking and strobing the echoes on the B-scope in the same manner as that for impact location (par. 38).

c. Burst locations are reported to FDC, and additional rounds are fired for adjustment until a range change of less than 100 meters is made, at which time fire for effect is commenced.

CHAPTER 8

PROCEDURE FOR MINIMIZING THE EFFECT OF JAMMING

56. Recognition of Jamming

The radar operator's first step is to learn to recognize the different forms of interference and to distinguish unintentional interference from interference caused by deliberate enemy jamming. Unintentional interference may result from the operation of nearby electrical equipment, or it may originate in the radar set itself. This interference will, at times, produce patterns on the radar scope similar to the patterns caused by enemy jamming. Interference caused by enemy jamming is indicated when interference patterns remain on the scope after interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that the interference is the result of enemy jamming the next step is to take all possible action (as indicated in pars. 57-61) to minimize the effects of the jamming and to continue operations. If, because of enemy jamming, an untrained operator shuts down his set with the mistaken idea that the set is defective, this operator is accomplishing the very effect the enemy desires. With training and practice, the operator can learn to distinguish unintentional interference from interference caused by enemy jamming and take the necessary counteraction.

57. Types of Jamming

Jamming is divided into two general categories. One category is transmission jamming, which is produced by a transmitter radiating a modulated or an unmodulated radio-frequency signal. The other category is mechanical jamming, produced by reflecting devices and intended to produce false targets or obscure actual target signals on the radar scope.

a. Transmission Jamming. Transmission jamming usually has a directional characteristic; that is, the jamming indication normally will be limited to a particular sector of the azimuth scanned by the radar being jammed. Transmission jamming, depending on the type of transmission used, will produce either strobe lines (extreme brightening of the sweep) or sector blanking (complete blanking of all indications) in the direction from which the jamming is arriving. However, if the jamming signal is extremely

strong, transmission jamming can completely saturate the radar scope and the direction from which the jamming is being received cannot be determined. From the counter-countermeasure viewpoint, it is important to note the direction of the jamming indication, when the jamming does have discernible directional characteristics, so that the jammer may be located and steps may be taken to reduce its effectiveness.

b. Mechanical Jamming. Mechanical jamming is produced by means other than active transmitters. Generally, this type of jamming is produced by reflecting items called window, rope, chaff, and straws. These reflecting items, normally in the form of various types, shapes, and sizes of metallic strips and metallic coated papers, usually are dropped from aircraft. The purpose of these items is to create false echoes or to produce large echoes, with the intention of shadowing or obscuring target signals from actual aircraft or missiles. Mechanical jamming also is produced by corner reflectors and metallized mesh and by stable, rotating, or oscillating dipoles. These types of window jamming devices are intended to produce strong false echoes which will obscure true target echoes or will capture tracking radars by causing the radar to lock in on the false echoes. False echo interference may be called deception rather than jamming. All window jamming devices operate on the same principle—that of reflecting the transmitted pulse from a radar set. Only by intensive training and experience can a radar operator learn to distinguish between true target echoes and echoes produced by window jamming devices.

58. Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he reports immediately to his superior the type of jamming received and the direction from which it is received. The operator also keeps a running record of information on the time, type, and direction of the jamming signal. Such information from two or more radar sites can provide data as to the exact location of the jammer and determine its movement if the jamming is originated from a moving source. These data can be used as a guide in resiting the radar equipment, or it may be used as fire direction data to place the site of the jammer under active fire with gun, missile, or aircraft. Reporting and recording of the jamming continue as long as the jamming indication is observed.

59. Procedure for Operation Against Transmission Jamming

After the type and direction of the jamming has been deter-

mined, the following procedures should be used by the AN/MPQ-4A radar operator to reduce the effectiveness of the jammer.

a. *Gain Control.* In continuous wave jamming, a gain setting less than that used for normal operation is usually most effective. A reduced gain setting prevents overloading of the receiver and allows the target pip to be seen riding on top of the jamming signal. Vary the GAIN control over its entire range to find the setting at which the target echo is best seen. When continuous wave jamming is strong enough to block the receiver completely, the GAIN control will not be effective in reducing the jamming effects. AUTOMATIC GAIN control may be an effective anti-jamming measure against continuous wave jamming.

b. *Local Oscillator.* Varying the local oscillator tuning a small amount may help in reducing the effects of continuous wave jamming if the jamming signal is confined to a narrow frequency band. Modulated jamming, however, will usually result in a signal of sufficient bandwidth to make varying the local oscillator ineffective as an anti-jamming measure.

c. *Siting.* The AN/MPQ-4A is difficult to jam unless *line of site* orientation exists between the jammer and the radar. Therefore, it is important that the radar be located in a defilade position. Proper siting may make it difficult for the enemy to locate a position from which the radar can be jammed effectively. Siting the radar set as prescribed also will reduce the possibility of interference from other friendly radars.

d. *Antenna Elevation.* If jamming occurs only when the jammer is in the main lobe of the radar antenna, some relief from jamming may be obtained if the vertical angle of the antenna is increased. Even though the tracking time and distance will be considerably lessened by the increased antenna elevation, the information obtained from the resultant plots will still be of appreciable value.

60. Procedure for Operating Against Window Jamming

To counter window jamming, adjust the INTENSITY, FOCUS, and GAIN controls for maximum definition. Window jamming indications usually appear as many closely spaced targets (clutter). Good definition helps in the separation of true target echoes from the jamming echoes and makes it easier to follow the definite movement of the target indication through the random movement of the jamming returns on the scope.

61. Reference

For further information on antijamming procedures, refer to TM 11-750, TM 11-751, and TM 11-1303.

CHAPTER 9

DECONTAMINATION OF EQUIPMENT

62. General

Equipment which has been contaminated by chemical, biological, or radiological agents constitutes a danger to personnel. *Contamination* means the spreading of an injurious agent in any form and by any means. Persons, objects, or terrain may be contaminated. *Decontamination* is the process of making any contaminated place or object safe for unprotected personnel. This can be done by covering, removing, destroying, or changing into harmless substances the contaminating agent or agents. Generally, only that equipment contaminated by persistent agents needs to be decontaminated.

63. Decontamination for Chemical Agents

With rags, wipe off all visible contaminant from the AN/MPQ-4A radar set and power unit exteriors, apply DANC (decontamination agent, noncorrosive, M4), wipe with gasoline-soaked rag, and then dry. If DANC is not available, scrub with soap and cool water. All air filters must be removed, soaked in gasoline, dried, recoated with heavy oil, and reinstalled.

64. Decontamination for Biological and Radiological Agents

a. General. After a contaminating attack, recovery of equipment may be achieved either by waiting, to permit the decay of the contaminants, or by actively decontaminating the equipment, to reduce danger to a level where it is no longer a significant hazard to operating personnel. Decontamination may be either rough or detailed, depending on the urgency of the military situation. The procedure adopted will be a command decision.

b. Rough Decontamination. Rough decontamination is performed when urgency is the main factor. Its purpose is to reduce contamination sufficiently to permit personnel to work with, or close to, equipment for limited periods. Rough decontamination may be achieved by means of water or steam, if available. Soap or other detergent used in conjunction with water or steam aids in decontamination. Care must be taken in the disposal of the water used, since it has, in turn, become contaminated.

c. Detailed Decontamination. Detailed decontamination, in which the emphasis is on thoroughness, will be carried out in rear areas and repair bases and will include procedures of surface decontamination, aging and sealing, and disposal.

65. References

For further information on decontamination, see FM 21-40, TM 3-220, and TF 3-1407.

CHAPTER 10

DESTRUCTION OF EQUIPMENT

66. General

a. Tactical situations may arise in which it is necessary to abandon equipment in the combat zone. In such a situation all abandoned equipment must be destroyed to prevent its use by the enemy.

b. *The destruction of equipment subject to capture or abandonment in the combat zone will be undertaken only upon authority delegated by a division or higher commander.*

67. Principles

All sections will prepare plans for destroying their equipment in order to reduce the time required should destruction become necessary. The principles to apply are as follows:

a. Plans for destruction of equipment must be adequate, uniform, and easily carried out in the field.

b. Destruction must be as complete as the available time, equipment, and personnel will permit. Since complete destruction requires considerable time, *priorities* must be established so that the more essential parts are destroyed first.

c. The same essential parts must be destroyed on all like units to prevent the enemy from constructing a complete unit from damaged ones.

d. Spare parts and accessories must be given the same priorities as the parts installed on the equipment.

68. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priority of destruction.

69. References

For detailed information on destruction of the radar set AN/MPQ-4A, see TM 11-5840-208-10.

CHAPTER 11

SAFETY PRECAUTIONS

70. Principles

Using personnel will not perform maintenance or inspections on the radar equipment beyond those specifically authorized in this manual and in the appropriate technical manual.

71. Precautions

a. Dangerous voltage is used in the operation of the radar equipment. Be careful when working on or near the 440-volt plate and power supply circuits, or on the 120-volt AC line connections. *Extremely high voltages* exist in the following units:

Duplexer tube assembly.....	700 volts
Power supply PP-1588/MPQ-4A.....	700 volts
Indicator, azimuth and range IP-375/MPQ-4A.....	14,000 volts
Modulator transmitter.....	26,000 volts

b. Do not refuel the power unit and do not handle or leave open gasoline containers in the vicinity of the radar set while the radar transmitter is on.

c. Radio-frequency energy transmitted by the radar set can produce damaging effects on body tissue. Serious burns may result if personnel stand or walk in the path of radiation while the radar set is transmitting.

d. Radioactive material is contained in types OB2 WA and BL-35 tubes. These tubes are potentially dangerous when broken. If handling personnel are cut by the broken tube, emergency medical attention is required. For specific instructions, see TB SIG 225.

72. Electric Shock

Electric shock accidents may cause breathing to cease. A casualty may recover if artificial respiration is applied promptly and efficiently. Principles and procedures for electric shock are described in FM 21-11.

CHAPTER 12

TRAINING

73. Purpose and Scope

The purpose of this chapter is to present the requirements for training the personnel of a radar section in the performance of their duties. It includes general information on the conduct of training.

74. Objectives

The objectives are to train radar crewmen rapidly in their individual duties and, through drill, to weld them into an effective, coordinated team able to function effectively in combat. Optimum efficiency is attained through frequent drills.

75. Conduct of Training

a. Training will be conducted in accordance with the principles set forth in FM 21-5. The goal of training should be the standards set forth in AR 611-201, ASubjSed 6-156, and ATP 6-575.

b. Individual training is conducted by noncommissioned officers as far as practicable. Officers are responsible for preparing training plans, for conducting unit training, and for supervising and testing individual training.

c. Throughout training, the application of prior instruction to current training must be emphasized.

d. A record of the training received by each individual should be kept on a progress card by each chief of section for each man in his section. This card should show each period of instruction attended, tests taken, and remarks pertaining to progress. Progress cards should be inspected frequently by the radar officer to make sure that they are being kept properly and to determine the state of training. *Requiring the chief of section to keep these records emphasizes his responsibility toward his section.*

e. The necessity for developing leadership and initiative in non-commissioned officers must be emphasized constantly throughout training.

76. Standards To Be Attained

A satisfactorily trained radar section must know the duties of other members of the section. Section personnel must be able to perform efficiently in all positions. This goal is attained by rotation of duties during training.

APPENDIX

REFERENCES

1. Field Manual

FM 5-15	Field Fortifications.
FM 5-20	Camouflage, Basic Principles and Field Camouflage.
FM 5-25	Explosives and Demolitions.
FM 6-20	Field Artillery Tactics and Techniques.
FM 6-21	Division Artillery.
FM 6-40	Field Artillery Cannon Gunnery.
FM 6-125	Qualification Tests for Specialists, Field Artillery.
FM 6-140	The Field Artillery Battery.
FM 21-5	Military Training.
FM 21-11	First Aid for Soldiers.
FM 21-30	Military Symbols.
FM 21-40	Small Unit Procedures in Nuclear, Biological and Chemical Warfare.
FM 21-60	Visual Signals.
FM 22-5	Drills and Ceremonies.
FM 25-10	Motor Transportation, Operations.

2. Technical Manual

TM 3-220	Decontamination.
TM 9-803	Truck, Utility, 1/4-Ton, 4X4.
TM 9-8022	Truck, Cargo, 2 1/2-Ton, 6X6.
TM 9-1900	Ammunition, General.
TM 9-2002	Launcher, Rocket, 3.5-Inch.
TM 9-2810	Tactical Motor Vehicle Inspection and Preventive Maintenance Service.
TM 11-286	Radar Set, AN/VRC-9.
TM 11-2330-234-15	Operation and Organizational, Field and Depot Maintenance, Trailer M454.
TM 11-5840-208-10	Operator's Manual, Radar Set AN/MPQ-4A.
TM 11-5840-208-20	Organizational Maintenance, Radar Set AN/MPQ-4A.

TM 11-5840-208-20P Organizational Maintenance Repair Parts
and Special Tool List for Radar Set
AN/MPQ-4A.

3. Miscellaneous

AR 611-201	Enlisted Military Occupational Specialties.
AR 750-5	Maintenance Responsibilities and Shop Operation.
ATP 6-100	Army Training Program for Field Artillery Unit.
DA Form 6-39	Radar Observed High Burst Registration.
DA Form 6-40	Radar Observed Center of Impact Registration.
DA Form 468	Unsatisfactory Equipment Report.
DA Pam 310 series	Index of Military Publications.
TB 5-5264-1	Generator Set, PU-107A/U.
TF 6-3096	Radar Set, AN/MPQ-4A.

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BY ORDER OF THE SECRETARY OF THE ARMY:

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NG: State AG (3); units—same as Active Army except allowance is one copy to each unit.

USAR: Same as Active Army except allowance is one copy to each unit.
For explanation of abbreviations used, see AR 320-50.

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